5-6115-545-34

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| NAVY | NAVFAC P-8-626-34 |
| MARINE CORPS | TM-00038G-35 |

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TECHNICAL MANUAL

# INTERMEDIATE (FIELD) (DIRECT AND GENERAL SUPPORT) AND DEPOT MAINTENANCE MANUAL

# GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL

## SKID MTD., 60 KW, 3 PHASE, 4 WIRE, 120/208 AND 240/416 VOLTS

| DOD MODELS | CLASS | HERTZ | FSN |
|---|---|---|---|
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| MEP105A | PRECISE | 50/60 | 6115-118-1252 |
| MEP115A | PRECISE | 400 | 6115-118-1253 |

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| MEP006AWE | WINTERIZATION KIT, ELECTRIC | 6115-455-7693 |
| MEP006ALM | LOAD BANK KIT | 6115-407-8322 |
| MEP006AWM | WHEEL MOUNTING KIT | 6115-463-9092 |

This copy is a reprint which includes current pages from Changes 1 thru 9.

10 JUNE 1973

Published under authority of the
Departments of the Air Force, the Army, and the Navy
(Including U. S. Marine Corps)

READEX FICHE best copy available
Reproduced from poor document.

D 101. 11:

## WARNING

All specific cautions and warnings contained in this manual shall be strictly adhered to. Otherwise, severe injury, death and/or damage to the equipment may result.

### HIGH VOLTAGE

is produced when this generator set is in operation.

### DEATH

or severe burns may result if personnel fail to observe safety precautions. Do not operate this generator set until the ground terminal stud has been connected to a suitable ground. Disconnect the battery ground cable before removing and installing components on the engine or in the electrical control panel system.

Do not attempt to service or otherwise make any adjustments, connections or reconnections of wires or cables until generator set is shut-down and completely de-energized.

### DANGEROUS GASES

Batteries generate explosive gas during charging; therefore, utilize extreme caution, do not smoke, or use open flame in vicinity when servicing batteries.

Exhaust discharge contains noxious and deadly fumes. Do not operate generator sets in inclosed areas unless exhaust discharge is properly vented to the outside.

### DANGEROUS GASES (Cont)

When filling fuel tank, maintain metal to metal contact between filler nozzle and fuel tank. Do not smoke or use an open flame in the vicinity.

Use extreme care, should a selenium rectifier malfunction, to avoid inhalation of poisonous fumes.

### LIQUIDS UNDER PRESSURE

are generated as a result of operation of the generator set. Do not expose any part of the body to a high pressure leak in the fuel or hydraulic system of the generator set.

Relieve pressure from radiator before removing radiator cap.

### NOISE

operating level of this generator can cause hearing damage. Ear protectors, as recommended by the medical or safety officer, must be worn when working near this set.

## CAUTION

### DAMAGE

to the equipment may result if personnel fail to observe the cautions contained in this manual.

If generator set is shut-down by the operation of a safety device, do not attempt to operate the unit until the cause has been determined and eliminated.

ARMY TM 5-6115-545-34
AIR FORCE TO-35C2-3-444-2
NAVY NAVFAC P-8-626-34
MARINE CORPS TM-00038G-35
C 9

CHANGE
NO. 9

DEPARTMENT OF THE ARMY,
THE AIR FORCE, AND THE NAVY
(INCLUDING U.S. MARINE CORPS)
WASHINGTON, D.C., 12 January 1987

Intermediate (Field)(Direct and General Support)
and Depot Maintenance Manual

# GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL SKID MTD., 60 KW, 3 PHASE, 4 WIRE, 120/208 AND 240/416 VOLTS

| DOD MODELS | CLASS | HERTZ | FSN |
|---|---|---|---|
| MEP006A | UTILITY | 50/60 | 6115-118-1243 |
| MEP105A | PRECISE | 50/60 | 6115-118-1252 |
| MEP115A | PRECISE | 400 | 6115-118-1253 |

## INCLUDING OPTIONAL KITS

| DOD MODELS | NOMENCLATURE | FSN |
|---|---|---|
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| MEP006AWE | WINTERIZATION KIT, ELECTRIC | 6115-455-7693 |
| MEP006ALM | LOAD BANK KIT | 6115-407-8322 |
| MEP006AWM | WHEEL MOUNTING KIT | 6115-463-9092 |

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TM 5-6115-545-34 ARMY
TO 35C-3-444-2 AIR FORCE
NAVFAC P-8-626-34 NAVY
TM-00038G-35 MARINE CORPS

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DISTRIBUTION:

To be distributed in accordance with DA Form 12-25A, Direct and General Support Maintenance requirements for Generator Set, Diesel Driven, Tactical, Skid Mounted, 120/208V, 240/416V, 3 PH, 4 Wire (50/60HZ: MEP-006A, MEP-105A; 400HZ: MEP-115A) (TM 5-6115-545 Series)

ARMY
AIR FORCE
NAVY
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TM 5-6115-545-34
TO 35C2-3-444-2
NAVFAC P-8-626-34
TM-00038G-35
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CHANGE
No. 8

Department of the Army,
the Air Force, and the Navy
(Including U.S. Marine Corps)
WASHINGTON, D.C., 1 April 1986

# Intermediate (Field) (Direct and General Support) and Depot Maintenance Manual

## GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL SKID MTD., 60 KW, 3 PHASE, 4 WIRE, 120/208 AND 240/416 VOLTS

| DOD MODELS | CLASS | HERTZ | FSN |
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| MEP006AWE | WINTERIZATION KIT, ELECTRIC | 6115-455-7693 |
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NAVFAC P-8-626-34 NAVY
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*Brigadier General, United States Army*
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DISTRIBUTION:
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TM 5-6115-545-34
TO 35C2-3-444-2
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CHANGE No. 7

Department of the Air Force,
the Army, and the Navy
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WASHINGTON, D.C., 20 October 1983

# INTERMEDIATE (FIELD) (DIRECT AND GENERAL SUPPORT) AND DEPOT MAINTENANCE MANUAL

## GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL SKID MTD., 60 KW, 3 PHASE, 4 WIRE, 120/208 and 240/416 VOLTS

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Marine Corps:
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Department of the Air Force,
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# INTERMEDIATE (FIELD) (DIRECT AND GENERAL SUPPORT) AND DEPOT MAINTENANCE MANUAL

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MARCORPS CODE: AGB

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AIR FORCE TO 35C2-3-444-2
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C4

TECHNICAL MANUAL

Change No. 4

Departments of the Air Force,
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Washington, DC, 31 August 1977

# INTERMEDIATE (FIELD) (DIRECT AND GENERAL SUPPORT) AND DEPOT MAINTENANCE MANUAL

# GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL

## SKID MTD., 60 KW, 3 PHASE, 4 WIRE, 120/208 AND 240/416 VOLTS

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Marine Corps:
MARCORPS CODE: AJH

ARMY TM-5-6115-545-34
AIR FORCE TO-35C2-3-444-2
NAVY NAVFAC P-8-626-34
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C 3

TECHNICAL MANUAL

Change No. 3

Departments of the Air Force,
the Army, and the Navy
(Including U. S. Marine Corps)

WASHINGTON, D.C. *1 July 1975*

# INTERMEDIATE (FIELD) (DIRECT AND GENERAL SUPPORT) AND DEPOT MAINTENANCE MANUAL

# GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL

## SKID MTD., 60 KW, 3 PHASE, 4 WIRE, 120/208 AND 240/416 VOLTS

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| 7-17, 7-18 | 7-17, 7-18 |
| 14-1, 14-2 | 14-1, 14-2 |
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To be distributed in accordance with DA Form 12-25D, Direct/General Support requirements for Generator Sets, 60 KW, 60 HZ Precise Power, 60 KW, 400 HZ Precise Power and 60 KW, 60 HZ Utility.
Marine Corps:
MARCORPS CODE AGC

DEPARTMENT OF THE ARMY TECHNICAL MANUAL
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TM-5-6115-545-34
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TM-00038G-35

TECHNICAL MANUAL

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 10 JUNE 1973

# INTERMEDIATE (FIELD) (DIRECT AND GENERAL SUPPORT) AND DEPOT MAINTENANCE MANUAL

# GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL

## SKID MTD., 60 KW, 3 PHASE, 4 WIRE, 120/208 AND 240/416 VOLTS

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| MEP105A | PRECISE | 50/60 | 6115-118-1252 |
| MEP115A | PRECISE | 400 | 6115-118-1253 |

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| MEP006AWM | WHEEL MOUNTING KIT | 6115-463-9092 |

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# CHAPTER 1

# INTRODUCTION

## Section 1. GENERAL

### 1-1. Scope.

a. This manual contains instructions for intermediate (field) (direct support, general support) and depot maintenance personnel maintaining the engine sets, 50/60 Hertz (Mode I) Tactical Utility (Class 2) and Tactical Precise (Class 1) and Engine Generator Sets, 400 Hertz (Mode II) Tactical Precise (Class I) as authorized by the maintenance allocation chart. It provides information on the maintenance of the equipment which is beyond the scope of the tools, equipment, personnel, or supplies normally available to the operator and organizational levels.

b. Demolition of material to prevent enemy use will be in accordance with the requirement of TM 750-244-3. (Procedures for Destruction of Equipment to Prevent Enemy Use for U.S. Army). Preparation for shipment and storage for U.S. Air Force will be in accordance with T.O. 35-1-4. Shipment and storage for U.S. Army will be in accordance with TB-740-97-2.

### 1-2. Forms and Records.

THIS TECHNICAL MANUAL IS USED BY THE ARMY, AIR FORCE, NAVY AND MARINE CORPS. THE USE OF FORMS IN COMPLIANCE WITH DIRECTIVES AS STATED HEREIN WILL BE ACCOMPLISHED ONLY BY THE PERSONNEL OF THE SERVICE TO WHICH THEY APPLY.

a. Forms and Records used by the Army will be only those prescribed by TM 38-750. Those used by the Marine Corps will be those prescribed by TM4700-15/1. Other service users should refer to appropriate specifications/publications for equipment maintenance forms and records.

b. Report of errors, omissions, and recommendations for improvement of this publication by the individual users should be submitted as follows:

(1) Air Force - AFTO Form 22. Direct to: Commander, Sacramento Air Materiel Area, McClellan Air Force Base, ATTN:MMST California 95652, in accordance with TO-00-5-1.

(2) Army - DA Form 2028. Direct to: Commander, U.S. Army Troop Support and Aviation Materiel Readiness Command, ATTN: DRSTS-MTPS, 4300 Goodfellow Blvd., St. Louis, MO 63120.

(3) Marine Corps - NAVMC Form 10772. Direct to: Commandant, U.S. Marine Corps, ATTN: LMO-1, Washington, D.C. 20380.

(4) Navy - by letter. Direct to: Commanding Officer, U.S. Navy, Ships Parts Control Center, ATTN: Code 783, Mechanicsburg, Pa., 17055.

## Section II. DESCRIPTION AND DATA

### 1-3. Description.

A general description of the diesel engine generator sets and information pertaining to the identification plates are contained in the Operator and Organizational Maintenance Manual. Detailed descriptions of the components of the diesel engine generator sets are provided in the applicable maintenance paragraphs of this manual.

### 1-4. Time Standards.

Table 1-1 lists the number of man-hours required under normal conditions to perform the indicated maintenance and repair for the generator set. Components are listed under the appropriate group number. The times listed are not intended to be rigid standards. Under adverse conditions, the operations will take longer, but under ideal conditions with highly skilled mechanics, most of the operations can be accomplished in less time.

### 1-5. Tabulated Data.

a. General. This paragraph contains all maintenance data pertinent to intermediate (field) (direct, general support) and depot maintenance personnel.

b. Engine Generator Set. Refer to Operator and Organizational Maintenance Manual.

c. Main Generator. (50/60 Hz) Exciter field voltage and current versus load, see the following:

**Exciter Field Voltage and Current Versus Load**

| Frequency | | | Percent of Rated Load | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 Exciter Volts | Amps | 25 Exciter Volts | Amps | 50 Exciter Volts | Amps | 75 Exciter Volts | Amps | 100 Exciter Volts | Amps | 125 Exciter Volts | Amps |
| 50 HZ | 8.23 | 2.35 | 10.3 | 2.95 | 12.4 | 3.55 | 14.5 | 4.15 | 16.6 | 4.75 | 19.3 | 5.5 |
| 60 HZ | 4.2 | 1.35 | 5.74 | 1.85 | 7.3 | 2.35 | 8.84 | 2.85 | 10.4 | 3.35 | 11.94 | 3.85 |

d. Main Generator. (400 Hz) Exciter field voltage and current versus load, see the following:

Exciter Field Voltage and Current Versus Load

| Frequency | | | Percent of Rated Load | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 Exciter Volts | Amps | 25 Exciter Volts | Amps | 50 Exciter Volts | Amps | 75 Exciter Volts | Amps | 100 Exciter Volts | Amps | 125 Exciter Volts | Amps |
| 400 HZ | 11.1 | 3.35 | 12.2 | 3.70 | 13.04 | 3.95 | 14.2 | 4.30 | 15.3 | 4.65 | 13.3 | 4.95 |

e. Engine. Refer to Operator and Organizational Maintenance Manual.

f. Excitation Assembly.

DOD drawing No. 70-1367........50/60 Hz
DOD drawing No. 70-1368........400 Hz
Type.............solid state, with capability to automatically flash field of generator.
Voltage regulation:
Precise sets.......1 percent of rated voltage.
Utility sets........ 3 percent of rated voltage.
Voltage stability:
Short term (30 seconds)
Precise sets. .....within bandwidth equal to 1 percent of rated voltage.
Utility sets........within bandwidth equal to 2 percent of rated voltage.
Long term (4 hours)
Precise sets......within bandwidth equal to 2 percent of rated voltage.
Utility sets.......within bandwidth equal to 4 percent of rated voltage.
Voltage Drift (8 hours)....1 percent with a change ambient temperature up to 60°F (33.3°C).

Transient performance (application or rejection of rated load).
Resumption of steady state condition:
Precise sets.......within 0.5 second.
Utility sets. .......within 3 seconds.
Overshoot and Undershoot:
Precise sets (50/60 Hz)....15 percent of rated voltage.
Precise sets (400 Hz)......12 percent of rated voltage.
Utility sets...............20 percent of rated voltage.

g. Engine Accessories.

(1) Fuel injection pump.

Manufacturer. ......Roosa Master
Model.............. DCMFC 629-2LQ
Type...............Fuel metering distributor, twin cylinders
Drive type..........gear
Governor type.......flyweight (centrifugal)
Rotation............Clockwise (viewed from driven end).
Cylinders (output) ....6
Mounting............ Flange
Plunger diameter .. 0.290 inches
Operational Data
Line pressure (maximum permissible) 8000 psi
Maximum permissible transfer pump pressure 130 psi
Transfer pump lift at 200 pump rpm (minimum) 18 in. high
Pump speed (maximum permissible) 3000 rpm

(2) Fuel transfer pumps. Refer to Operator and Organizational Maintenance Manual.

(3) Governor hydraulic actuator.

DOD drawing no....... 69-790-2.
Position transducer.... variable reluctance type.
Input pressure......... 320 psi.
Type.................. differential pressure operated.
Gpm.................. 2.

(4) Hydraulic pump.

Manufacturer...........John S. Barnes.
Manufacturer's model no....GC-5183-A-DA.

| | |
|---|---|
| **Capacity** | **2.6 gpm at 3600 rpm at 320 psi.** |
| **Rotation** | clockwise. |
| **Type** | **gear driven.** |
| **Relief valve type** | adjustable. |
| **Relief valve setting** | 310/330 psi. |

(5) Turbocharger. Refer to Operator and Organizational Maintenance Manual.

(6) Electric starter. Refer to Operator and Organizational Maintenance Manual.

(7) Battery charging alternator. Refer to Operator and Organizational Maintenance Manual.

(8) Fuel solenoid valve.

| | |
|---|---|
| DOD drawing No. | 69-787-2. |
| Volts | 24 dc. |
| Watts | 10. |
| Input pressure | 25 psi. |
| Orifice size | 1/4 in. |

(9) Oil pump.

| | |
|---|---|
| Type | gear driven. |

(10) Oil cooler. Refer to Operator and Organizational Maintenance Manual.

(11) Water pump. Refer to Operator and Organizational Maintenance Manual.

h. Radiator. Refer to Operator and Organizational Maintenance Manual.

i. Safety Devices:

(1) Coolant high temperature switch. Refer to Operator and Organizational Maintenance Manual.

(2) Overspeed switch. Refer to Operator and Organizational Maintenance Manual.

(3) Low oil pressure switch. Refer to Operator and Organizational Maintenance Manual.

(4) Fuel Level Switch (day tank). Refer to Operator and Organizational Maintenance Manual.

**j. Electric Governor Control Unit (400 Hz).**

| | |
|---|---|
| **DOD drawing No.** | **69-784-1** |
| **Type** | **solid state** |
| **Volts Input** | **24 Vdc and 120 Vac from generator.** |
| **Control frequency** | **400 Hz** |
| **Power dissipation** | **115 watts max. at 400 Hz.** |
| **Frequency regulation** | **0.25 percent.** |

j.1 Governor Control Kit Classification and Rating

DOD Drawing Numbers:

| | |
|---|---|
| Governor control unit | 81-4903 |
| Magnetic actuator | 81-705 |
| Magnetic pickup | 81-4904 |
| Type: | Solid state |
| Input volts | 11-40 vdc |
| Frequency regulation | 0.25% |
| Temperature range | -65° to 185°F (-55° to 85°C) |

**k. Electric Governor Control Unit (50/60 Hz).**

| | |
|---|---|
| **DOD drawing No.** | **69-784-2** |
| **Model** | **LEH** |
| **Type** | solid state |
| **Volts input** | **24Vdc and 120 Vac from generator.** |
| **Control frequency** | **50/60 Hz.** |
| Power dissipation | 115 watts max. at 60 Hz. |
| Frequency regulation | 0.25 percent. |

l. Relays.

(1) Overvoltage relay.

| | |
|---|---|
| DOD drawing No. | 70-1138 |
| Nominal voltage | 120 volts, 50 - 450 Hz. operates at 153 ± 3 volts for frequencies 50 to 450 Hz. |
| Time delay | operates when over-voltage condition is sustained for a minimum of 200 milliseconds. |
| Trip time | less than 1.0 sec. after voltage reaches and stays at pull-in value. |
| Contact rating | 10 amperes, 28.5 volts, resistive. |
| Temperature limits | -65° F to + 170° F. |
| Temperature effect on pull-in voltage | + 77° F to - 65° F decreases min. 1 volt. + 77° F to + 170° F changes min. ± 1 volt. |

(2) Undervoltage relay.

| | |
|---|---|
| DOD drawing No. | 70-1120. |
| Nominal voltage | 120 volts, 50/400 Hz. |
| Dropout voltage | 99 ± 4 volts. |
| Pull in voltage | 110 ± 3 volts. |
| Time delay | 6 ± 2 seconds at drop-out. Instant at 48 volts and lower. |
| Contact rating | 10 amperes, 28 volts, resistive. |
| Contact arrangement | 2 pole double throw. |
| Temperature | - 65° to + 170° F. |
| Temperature effects on trip voltage | + 77° F to - 65°F ±1% max. + 77° F to 170° F ± 1% max. |

(3) Under frequency relays.

(a) 400 Hz sets.

| | |
|---|---|
| DOD drawing No. | 70-1141. |
| Input voltage | 120 volts nominal (400 Hz.) |
| Trip frequency | 370 Hz ± 5. |
| Voltage input limits | ± 10%. |
| Contact rating | 10 amperes, 28 volts resistive. |
| Temperature range | - 65° F to + 170° F. |
| Temperature effect on trip point | - 65°F to + 77° F ± 1 Hz. max change. + 77° F to + 170° F. |

### (b) 50/60 Hz sets

| | |
|---|---|
| DOD drawing No. | 70-1119. |
| Input voltage. | 114 - 139 volts, 50/60 Hz. |
| Trip frequency. | 46 Hz ± 1 Hz or 55 Hz ± 1 Hz. |
| Voltage input limits | ± 10%. |
| Temperature range | -65°F to + 170°F. |
| External power required | none. |
| Contact rating | 10 amperes, 28 Vdc, resistive. |

### (4) Short circuit relay.

| | |
|---|---|
| DOD drawing No. | 70-1137. |
| Trip voltage | 24 volts ± 1, any phase to neutral. |
| Contact rating | 10 amperes, 28 Vdc. |
| Frequency. | 50/400 Hz. |
| Temperature range | -65°F to + 170°F. |
| Temperature effect on trip point | -65°F to +77°F ± 2 percent max. change. +77°F to + 170°F ± 3 percent max. change. |

### (5) Reverse power relay.

| | |
|---|---|
| DOD drawing No. | 70-1136. |
| DC input voltage | 0/10 volts with ac voltage superimposed on dc input voltage up to 20 volts. |
| External power | 24 volts dc. |
| Reverse polarity. | approx. 20 percent reverse power. |
| Temperature limits | -65°F to + 170°F. |
| Temperature effect on trip point | -65°F + 3 volts + 77° F + 2 volts. +170°F + 1.5 volts. |
| Reverse trip voltage | + 2 volts. |
| Contact rating | 10 amperes, 28 Vdc. |

### (6) Permissive paralleling relay.

| | |
|---|---|
| DOD drawing No. | 70-1118. |
| External power required | 24 Vdc. |
| Operating level | contacts close when signal input voltage falls below 8 volts ± 1, 50/400 Hz. |
| Temperature limit | -65°F to + 170°F. |
| Contact rating | 28 volts, 10 amperes, resistive. |

### m. Load measuring unit.

| | |
|---|---|
| DOD drawing No. | 69-785. |
| Use. | 50 to 400 Hz systems. |

### n. Contactor

| | |
|---|---|
| DOD drawing No. | 69-680. |
| Construction | gasket sealed. |
| KVA rating (maximum) | 125 KVA 50/60 and 400 Hz. |
| Main contacts | 3 psi + (double break). |
| Voltage ac | 120/208 and 240/416. |
| Frequency | 50/60 and 400 Hz. |
| Continuous current | 350 amperes, 208 volts. 50/60 and 400 Hz. |
| 6 second current | 750 amperes at 50/60 and 400 Hz. |
| Interruption (maximum) | 5000 amperes, 50/60 and 400 Hz. 120/208 volts 2500 amperes 50/60 and 400 Hz 240/416 volts. |
| Mechanism | electrically held. |
| Auxiliary contacts: | |
| Voltage dc | 28 volts. |
| Current | 7.5 amperes. |
| Voltage ac | 120 volts. |
| Lamp current | 7.5 amperes. |
| Contact operation | auxiliary contacts operate 0.001 to 0.003 second after main contacts close and 0.003 to 0.005 second after main contact opens. |
| Temperature range | 55° to 71°C. |
| Coil data | |
| Operating voltage (without external resistance) | |
| (maximum) | 32 volts. |
| (minimum) | 18 volts. |
| Operating time at voltage close release | 0.050/0.035 second at 30/18 Vdc. |
| Close coil resistance | 8 ohms. |

### o. Thermal Watt Converter, 50/60 Hz.

| | |
|---|---|
| DOD drawing No. | 69-589-1. |
| Volts | 100/130. |
| Current. | 1 ampere. |
| Elements | 3. |
| Phase | 3. |
| Number of wires. | 4. |
| Output | 20 MV dc, open circuit. |
| Output circuit resistance | 4.97 ohms. |
| Watts per element | 96.26. |

### p. Thermal Wall Converter, 400 Hz.

| | |
|---|---|
| DOD drawing No. | 69-589-2. |
| Volts | 100/130. |
| Current | 1 ampere. |
| Elements | 3. |
| Phase | 3. |
| Wire | 4. |
| Output | 20 MV dc, open circuit. |
| Output circuit resistance | 4.97 ohms. |
| Watts per element | 96.3. |

### q. Alternator.

#### (1) Stator coils winding data 50/60 Hz.

| | |
|---|---|
| Type | 3 phase. |
| No. of slots and coils | 84/84. |
| Turns per coil | 4. |
| Coils per group | 7. |
| Conductor | 6 of AWG 15. |
| Span | 1 - 15 span. |

#### (2) Rotor coils winding data 50/60 Hz.

| | |
|---|---|
| Resistance | 0.390 ohm at 25°C. |
| Conductor | 9 of AWG #16 (0.0508). |
| Turns per coil | 103. |
| No. of poles and coils | 4. |

#### (3) Stator coils winding data 400 Hz.

| | |
|---|---|
| Type | 3 phase. |
| No. of slots and coils | 108/108. |
| No. of coils per group | 36 groups of 2,<br>36 groups of 1. |
| Turns per coil | 5. |
| Span | 1-4. |
| Conductor | AWG 16 and AWG 17. |

#### (4) Exciter stator winding data.

| | |
|---|---|
| Type of winding | salient pole dc. |
| No. of slots and coils | 10 slots, 10 coils. |
| No. of coils per group | 1. |
| Turns per coil | 196. |
| Span | 1-2. |
| Conductor | 1 of AWG #21 (0.0285).<br>1 of AWG #22 (0.0253). |

#### (5) Rotor coils winding data 400 Hz.

| | |
|---|---|
| No. of poles and coils | 24. |
| Turns per coil | 30. |
| Conductor | 4 of AWG 15. |

#### (6) Exciter rotor winding data.

| | |
|---|---|
| Type of winding | 3 phase. |
| No. of slots and coils | 36 slots, 36 coils. |
| No. of coils per group | 6 groups of 2, 24 groups of 1. |
| Turns per coil | 3 for 60/50 Hz, 5 for 400 Hz. |
| Span | 1-4. |
| Conductor | 5 of AWG #16 (0.0508) 60/50 Hz. 3 of AWG #16 (0.0508) 400 Hz. |
| Insertion sequence | 211/112/111/121/111 and repeat. |

r. Engine Repair and Replacement Standards. Table 1-2 lists manufactorer's sizes, tolerances, and maximum allowable wear and clearances.

s. Schematic Wiring Diagrams. Figures 1-1 through 1-15 show the schematic wiring diagrams for the 50/60 Hz and 400 Hz engine generator sets, as well as schematic and wiring diagrams for electrical assemblies, relay boxes and kits.

### t. Torque Values.

(1) Table 1-3 lists specific torque values.

(2) All torque values are calculated for oil lubricated threads. Increase this value by 10 percent when threads are not lubricated.

u. Unit Function Differences. The engine generator sets are provided in three configurations according to class and mode of operation. The class designation of a unit is determined by its frequency and voltage performance and the mode designation is dependent upon the output frequency. Table 1-4 provides a quick reference for determining engine generator set classification and special component complement required.

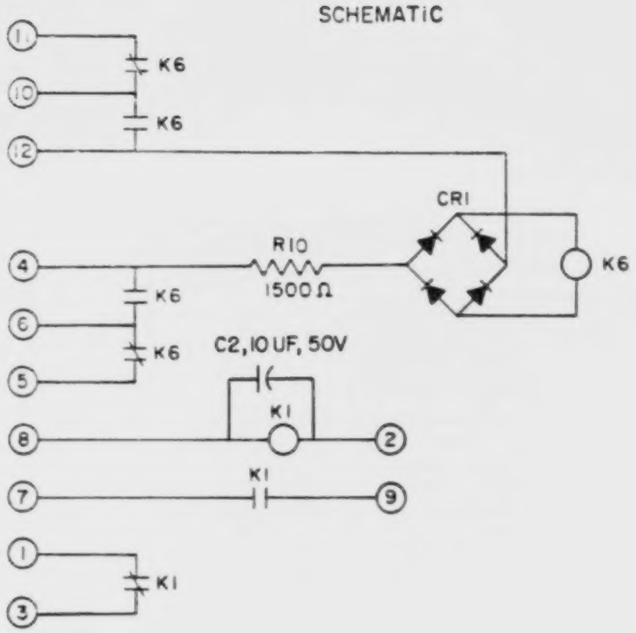
v. Performance Characteristics. The electrical performance characteristics for Class 1 and Class 2 sets are provided in tables 1-5 and 1-6.

Table 1-1. Time Standards

| MAC chart group no. | Removal and replacement | Man hours |
|---|---|---|
| 10 | Load connection group current transformer assembly | 1.0 |
| 11 | Governor control unit | 0.3 |
| 13 | Relay table group | ----- |
| | Tactical relay assembly | 0.6 |
| | Precise relay assembly | 0.6 |
| | Special relay assembly | 0.6 |
| | Excitation assembly | 0.6 |
| | Exciter | 0.6 |
| | Voltage regulator | 0.6 |
| | Load measuring unit | 0.6 |
| 14 | Generator assembly | ----- |
| | Bearing | 7.8 |
| | Rectifier rotating | 8.0 |
| | Fan, generator | 12.0 |
| | Rotor assembly | 12.0 |
| | Stator, exciter assembly | 9.0 |
| | Stator, generator assembly | 12.0 |
| 16 | Lifting frame assembly | --- |
| | Lifting frame | 2.0 |
| 18 | Hydraulic actuator | 0.4 |
| 20 | Engine assembly | --- |
| | Alternator/battery charging | --- |
| | Diodes | 1.8 |
| | Brush assembly | 0.5 |
| | Rotor | 2.0 |
| | Field assembly | 2.0 |
| | Voltage regulator (dc) | 1.1 |
| | Hydraulic pump and drive assembly | 0.5 |
| | Speed switch and drive speed switch | --- |
| | Adapter | 0.4 |
| | Tach drive | 0.6 |
| | Electric starter and adapter | --- |
| | Starter assembly | 1.0 |
| | Brushes | 0.5 |
| | Solenoid, starter | 1.0 |
| | Armature, starter | 1.0 |
| | Drive, starter | 1.0 |
| | Field, assembly | 1.0 |
| | Lube oil cooler | --- |
| | Relief valve | 0.5 |
| | Pump, fuel injection | 1.7 |
| | Damper, vibration and crankshaft pulley | 1.5 |
| | Engine front support | 3.0 |
| | Oil pan assembly | 3.0 |
| | Oil pump | 2.3 |
| | Flywheel and housing | --- |
| | Flywheel assembly | --- |
| | Ring gear | 11.8 |
| | Flywheel | 10.0 |
| | Housing | 10.8 |

Table 1-1. Time Standards (Cont)

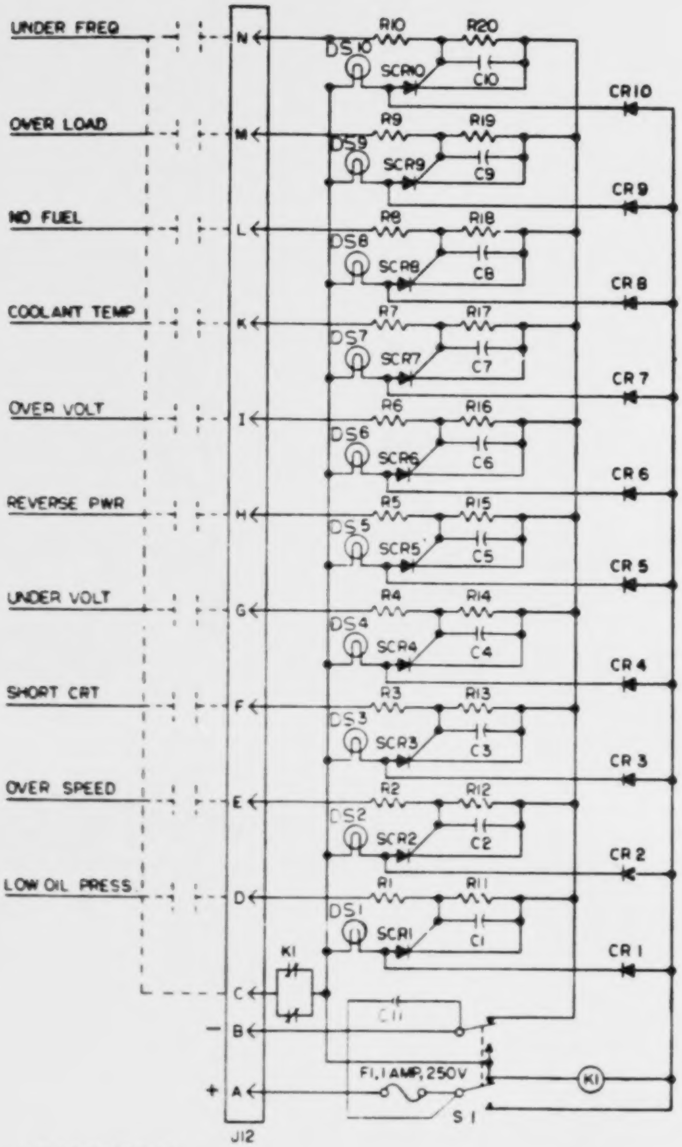
| MAC chart group no. | Removal and replacement | Man hours |
|---|---|---|
| | Timing gear and cover | 5.9 |
| | Cylinder head and valve operating mechanism | --- |
| | Rocker arm shaft assembly | --- |
| | Rocker arm assembly | 0.9 |
| | Pushrod | 0.6 |
| | Cylinder head assembly | --- |
| | Valves intake and exhaust | 5.9 |
| | Springs valve | 5.4 |
| | Seats intake and exhaust valves | 6.1 |
| | Guides, valve | 6.1 |
| | Head cylinder | 4.0 |
| | Lifters, valve | 14.8 |
| | Camshaft | 14.6 |
| | Piston and rings | --- |
| | Piston pin | 11.8 |
| | Connecting rod | 11.8 |
| | Rod bearings | 11.8 |
| | Piston rings | 11.9 |
| | Piston | 11.2 |
| | Crankshaft | 16.5 |
| 21 | Base group | |
| | Skid base | 40.0 |
| 25 | Winterization kit (fuel burning) | --- |
| | Control box assembly | --- |
| | Light assembly | 0.5 |
| | Circuit breaker | 0.5 |
| | Power switch | 0.5 |
| | Heater assembly | 0.7 |
| | Valve assembly, regulator | 0.6 |
| | Terminal board | 0.3 |
| | Switch, limit | 0.4 |
| | Switch, flame | 0.4 |
| | Coolant pump and motor assembly | 0.9 |
| | Pump | 0.5 |
| | Relief valve | 0.2 |
| | Motor assembly | 1.4 |
| | Fan | 1.6 |
| | Motor | 1.6 |
| | Burner chamber | 2.0 |
| | Heat exchanger | 1.6 |
| 26 | Heater kit, winterization (electric) | |
| | Coolant pump and motor assembly | --- |
| | Pump | 0.5 |
| | Relief valve | 0.2 |
| | Motor | 0.5 |
| | Control box | --- |
| | Wiring harness | 1.0 |
| | Transformers | 1.0 |
| | Relay | 1.0 |
| | Semi conductors | 1.0 |
| | Circuit breaker | 0.5 |
| | Power switch | 0.5 |
| | Fuse holder | 0.5 |
| | Light assembly | 0.5 |
| 27 | Wheel mounting kit | 8.0 |
| 28 | Load bank | |
| | Load reject relay | 1.0 |
| | Terminal board | --- |
| | Diodes | 0.5 |


SCHEMATIC
11
10
12
K6
K6
CR1
R10
1500Ω
K6
4
6
5
K6
K6
C2, 10 UF, 50V
K1
8
2
K1
7
9
1
3
K1

| REF. DES. | DESCRIPTION |
|---|---|
| C2 | CAPACITOR, FIXED |
| CR1 | FULL WAVE BRIDGE RECTIFIER |
| K1 | RELAY, STOP-RUN |
| K6 | RELAY, REMOTE VOLTAGE SENSING |
| R10 | RESISTOR, FIXED |

ME 6115-545-34/1-1 C1

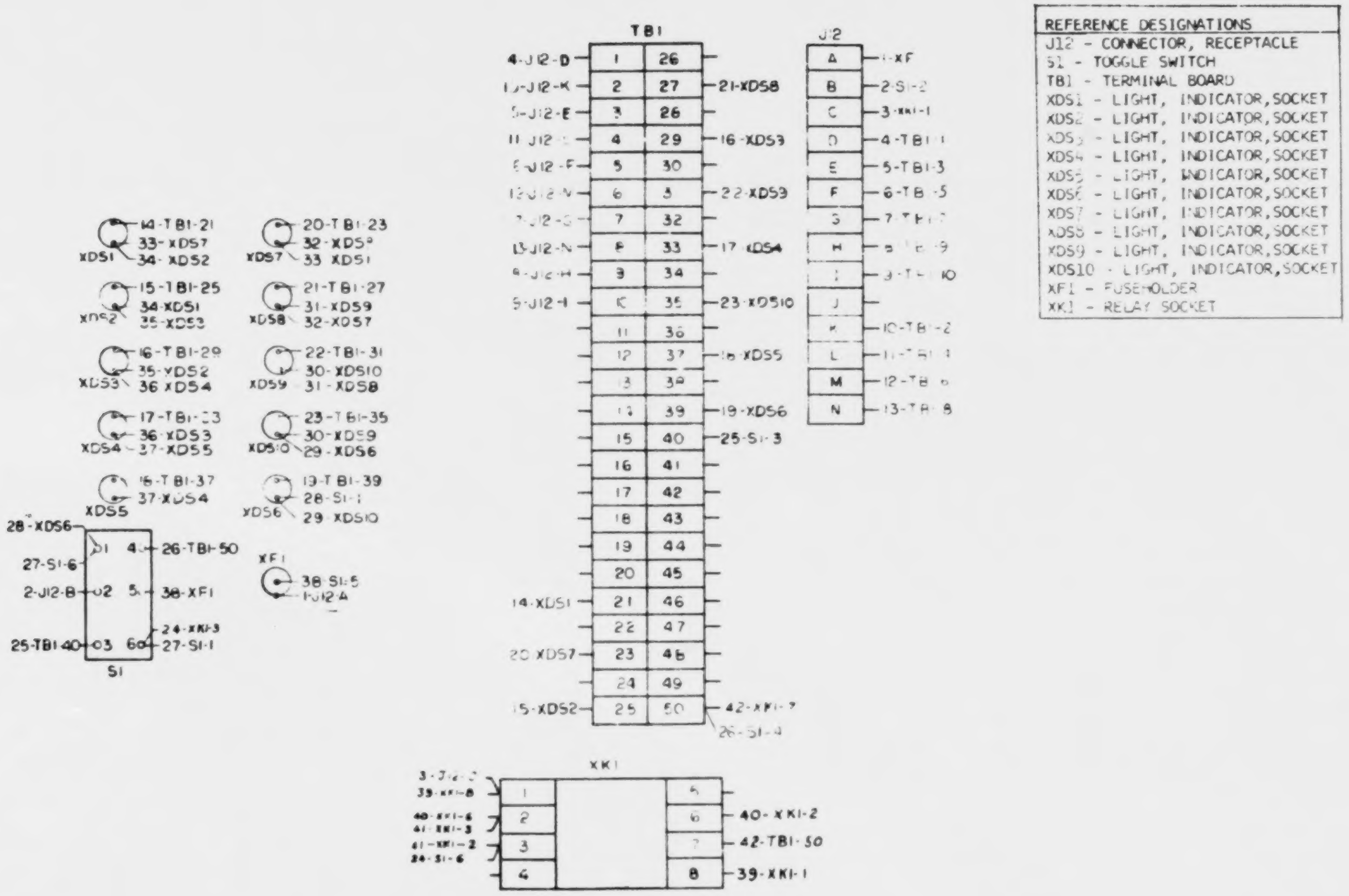
Figure 1-1. Schematic Diagram, Control Panel Relay, A4


UNDER FREQ
OVER LOAD
NO FUEL
COOLANT TEMP
OVER VOLT
REVERSE PWR
UNDER VOLT
SHORT CRT
OVER SPEED
LOW OIL PRESS
N
M
L
K
I
H
G
F
E
D
C
B
A
−
+
J12
R10
R20
DS10
SCR10
C10
CR10
R9
R19
DS9
SCR9
C9
CR9
R8
R18
DS8
SCR8
C8
CR8
R7
R17
DS7
SCR7
C7
CR7
R6
R16
DS6
SCR6
C6
CR6
R5
R15
DS5
SCR5
C5
CR5
R4
R14
DS4
SCR4
C4
CR4
R3
R13
DS3
SCR3
C3
CR3
R2
R12
DS2
SCR2
C2
CR2
R1
R11
DS1
SCR1
C1
CR1
K1
C11
F1, 1 AMP, 250V
S1
K1

| REF. DES. | DESCRIPTION |
|---|---|
| C1 THRU C10 | CAPACITOR, FIXED (.10 UF ± 10%, 200 VDC) |
| C11 | CAPACITOR, FIXED (6 UF, 75 VDC) |
| DS1 THRU DS10 | LAMP, INCANDESCENT .04 AMPS, 26 VOLTS |
| F1 | FUSE, 1 AMP, 250 V |
| K1 | RELAY, FAULT |
| R1 THRU R10 | RESISTOR, FIXED (2.2 K ± 10%, 1/2 W) |
| R11 THRU R20 | RESISTOR, FIXED (1K ± 10%, 1/2 W) |
| S1 | SWITCH, TEST/RESET |
| SCR1 THRU SCR10 | RECTIFIER (2N1596) |
| CR1 THRU CR10 | RECTIFIER(IN2610) |

ME 6115-545-34/1-2 C3

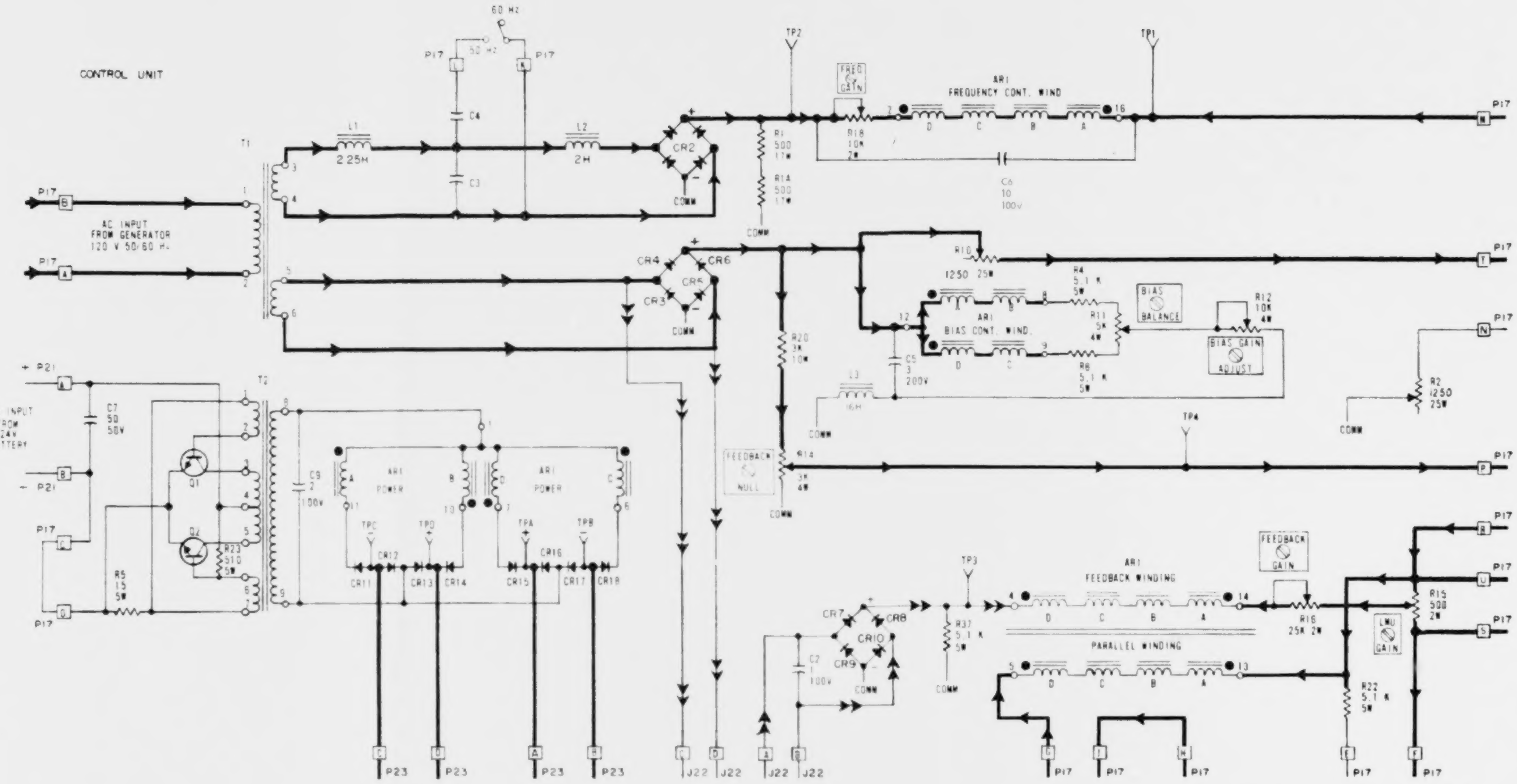
Figure 1-2. Schematic Diagram, Fault Indicator Panel


TB1
J12
XK1
S1
XF1
XDS1
XDS2
XDS3
XDS4
XDS5
XDS6
XDS7
XDS8
XDS9
XDS10
14-TB1-21
33-XDS7
34-XDS2
15-TB1-25
34-XDS1
35-XDS3
16-TB1-29
35-XDS2
36 XDS4
17-TB1-33
36-XDS3
37-XDS5
16-TB1-37
37-XDS4
20-TB1-23
32-XDS8
33 XDS1
21-TB1-27
31-XDS9
32-XDS7
22-TB1-31
30-XDS10
31-XDS8
23-TB1-35
30-XDS9
29-XDS6
19-TB1-39
28-S1-1
29-XDS10
28-XDS6
27-S1-6
2-J12-B
25-TB1-40
26-TB1-50
38-XF1
24-XK1-3
27-S1-1
38-S1-5
1-J12-A
4-J12-D
2-J12-K
5-J12-E
11-J12-L
6-J12-F
12-J12-M
7-J12-G
13-J12-N
8-J12-H
9-J12-I
14-XDS1
20-XDS7
15-XDS2
21-XDS8
16-XDS3
22-XDS9
17-XDS4
23-XDS10
18-XDS5
19-XDS6
25-S1-3
42-XK1-7
26-S1-4
1-XF
2-S1-2
3-XK1-1
4-TB1-1
5-TB1-3
6-TB1-5
7-TB1-7
8-TB1-9
9-TB1-10
10-TB1-2
11-TB1-4
12-TB1-6
13-TB1-8
39-XK1-8
40-XK1-6
41-XK1-3
41-XK1-2
24-S1-6
40-XK1-2
42-TBI-50
39-XK1-1

REFERENCE DESIGNATIONS
J12 - CONNECTOR, RECEPTACLE
S1 - TOGGLE SWITCH
TB1 - TERMINAL BOARD
XDS1 - LIGHT, INDICATOR,SOCKET
XDS2 - LIGHT, INDICATOR,SOCKET
XDS3 - LIGHT, INDICATOR,SOCKET
XDS4 - LIGHT, INDICATOR,SOCKET
XDS5 - LIGHT, INDICATOR,SOCKET
XDS6 - LIGHT, INDICATOR,SOCKET
XDS7 - LIGHT, INDICATOR,SOCKET
XDS8 - LIGHT, INDICATOR,SOCKET
XDS9 - LIGHT, INDICATOR,SOCKET
XDS10 - LIGHT, INDICATOR,SOCKET
XF1 - FUSEHOLDER
XK1 - RELAY SOCKET

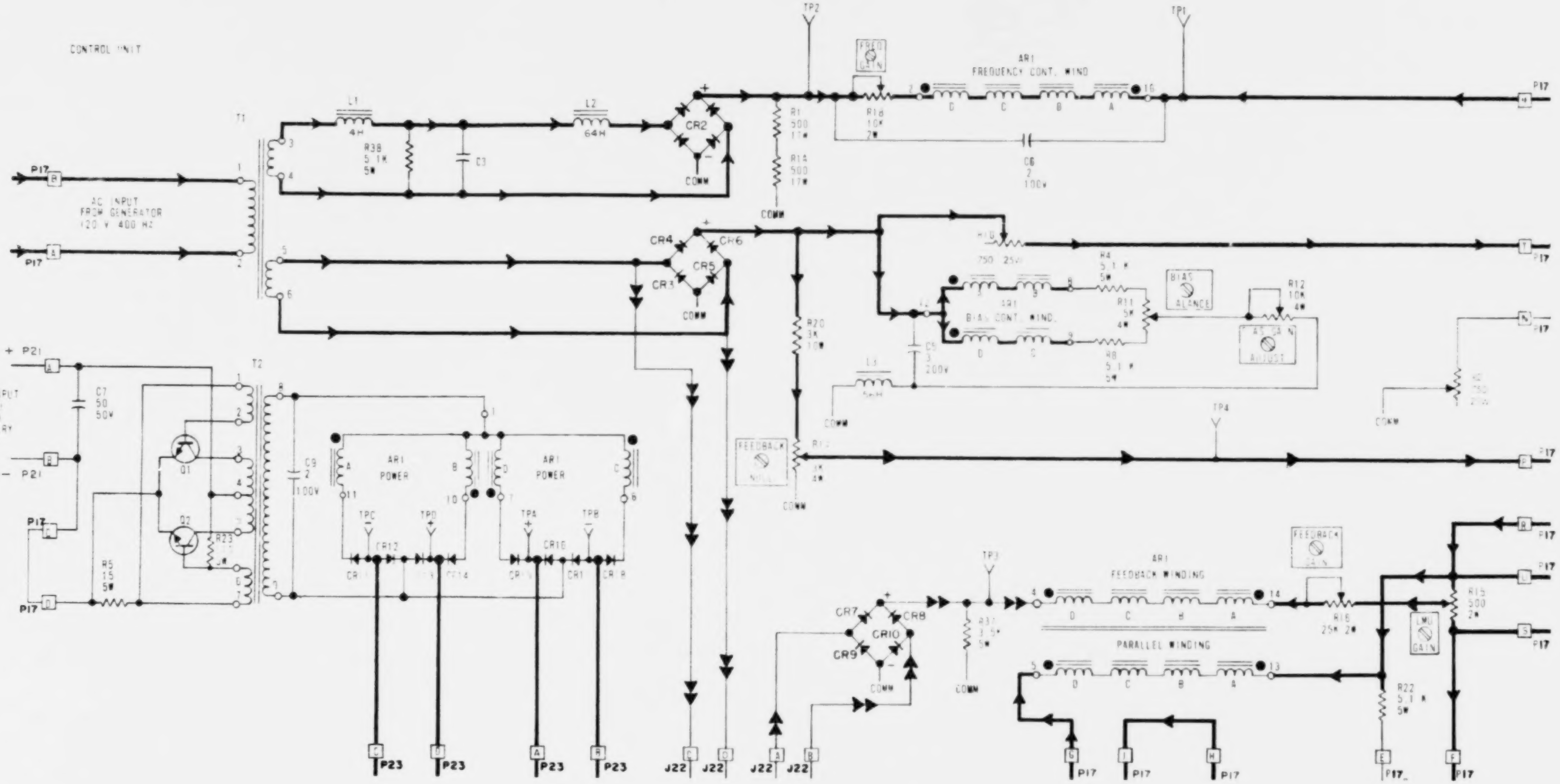
ME 6115-545-34/1-3

Figure 1-3. Wiring Diagram, Fault Indicator Panel


CONTROL UNIT
60 Hz
50 Hz
P17
TP2
TP1
FREQ GAIN
AR1 FREQUENCY CONT. WIND
R18 10K 2W
D
C
B
A
2
16
C4
C3
L1 2.25H
L2 2H
CR2
COMM
R1 500 17W
R1A 500 17W
C6 10 100V
T1
AC INPUT FROM GENERATOR 120 V 50/60 Hz
CR4
CR6
CR5
CR3
R10 1250 25W
R4 5.1 K 5W
BIAS BALANCE
R12 10K 4W
AR1 BIAS CONT. WIND
R11 5K 4W
BIAS GAIN ADJUST
R8 5.1 K 5W
C5 3 200V
L3 16H
R20 3K 10W
R2 1250 25W
TP4
FEEDBACK NULL
R14 3K 4W
+ P21
− P21
DC INPUT FROM 24V BATTERY
C7 50 50V
T2
Q1
Q2
R23 510 5W
R5 15 5W
C9 2 100V
AR1 POWER
TPC
TPD
TPA
TPB
CR11
CR12
CR13
CR14
CR15
CR16
CR17
CR18
TP3
AR1 FEEDBACK WINDING
PARALLEL WINDING
CR7
CR8
CR10
CR9
R37 5.1 K 5W
C2 1 100V
FEEDBACK GAIN
R16 25K 2W
R15 500 2W
LMU GAIN
R22 5.1 K 5W
P23
J22

| REF. DES. | DESCRIPTION |
|---|---|
| AR1 | FULL WAVE MAGNETIC AMPLIFIER |
| C2 | CAPACITOR, FIXED |
| C3 | CAPACITOR (SELECTED AT TEST) |
| C4 | CAPACITOR (SELECTED AT TEST) |
| C5 | CAPACITOR, FIXED |
| C6 | CAPACITOR FIXED |
| C7 | CAPACITOR, FIXED |
| C9 | CAPACITOR, FIXED |
| CR2 | FULL WAVE BRIDGE RECTIFIER |
| CR3-CR6 | FULL WAVE BRIDGE RECTIFIER |
| CR7-CR10 | FULL WAVE BRIDGE RECTIFIER |
| CR11 | DIODE |
| CR12 | DIODE |
| CR13 | DIODE |
| CR14 | DIODE |
| CR15 | DIODE |
| CR16 | DIODE |
| CR17 | DIODE |
| ■ CR18 | DIODE |
| J3 | CONNECTOR, RECEPTACLE |
| L1 | REACTOR |
| L2 | REACTOR |
| L3 | REACTOR, CHOKE |
| P1 | CONNECTOR, RECEPTACLE |
| P2 | CONNECTOR, RECEPTACLE |
| P3 | CONNECTOR, RECEPTACLE |
| Q1 | TRANSISTOR, POWER |
| Q2 | TRANSISTOR, POWER |
| R1 | RESISTOR, FIXED |
| R1A | RESISTOR, FIXED |
| R2 | RESISTOR, ADJUSTABLE |
| R4 | RESISTOR, FIXED |
| R5 | RESISTOR, FIXED |
| R8 | RESISTOR, FIXED |
| R10 | RESISTOR, ADJUSTABLE |
| R11 | RESISTOR, VARIABLE |
| R12 | RESISTOR, VARIABLE |
| R14 | RESISTOR, VARIABLE |
| R15 | RESISTOR, VARIABLE |
| R16 | RESISTOR, VARIABLE |
| R18 | RESISTOR, VARIABLE |
| R20 | RESISTOR, FIXED |
| R22 | RESISTOR, FIXED |
| R23 | RESISTOR, FIXED |
| R37 | RESISTOR, FIXED |
| T1 | TRANSFORMER |
| T2 | TRANSFORMER |
| TP1 | CONNECTOR, TEST JACK |
| TP2 | CONNECTOR, TEST JACK |
| TP3 | CONNECTOR, TEST JACK |
| TP4 | CONNECTOR, TEST JACK |
| TPA | CONNECTOR, TEST JACK |
| TPB | CONNECTOR, TEST JACK |
| TPC | CONNECTOR, TEST JACK |
| TPD | CONNECTOR, TEST JACK |

**Figure 1-4.** Schematic Diagram, Electric Governor Control Unit, (Mode I, Class 1) Sets



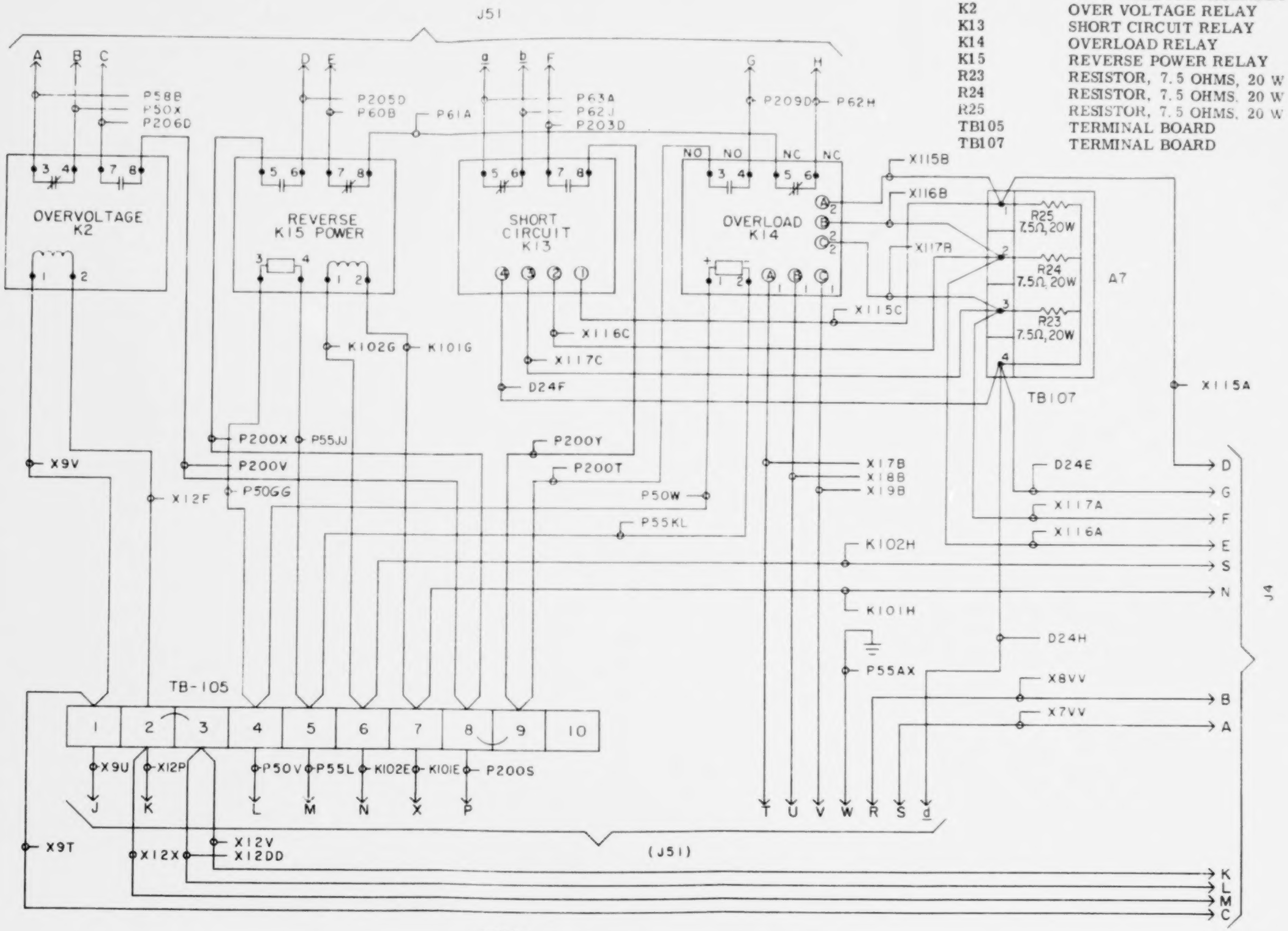
CONTROL UNIT
T1
L1 4H
L2 64H
CR2
R38 5.1K 5W
C3
AC INPUT FROM GENERATOR 120 V 400 HZ
P17
TP2
TP1
FREQ GAIN
AR1 FREQUENCY CONT. WIND
R18 10K 2W
R1 500 17W
R1A 500 17W
C6 2 100V
COMM
CR4
CR6
CR5
CR3
R10 750 25W
R4 5.1K 5W
BIAS BALANCE
R12 10K 4W
BIAS GAIN ADJUST
AR1 BIAS CONT. WIND
R11 5K 4W
R8 5.1K 5W
C5 3 200V
L3
R20 3K 10W
FEEDBACK NULL
R14 3K 4W
TP4
R2
+ P21
DC INPUT FROM 24V BATTERY
C7 50 50W
− P21
T2
Q1
Q2
R23
R5 15 5W
C9 2 100V
AR1 POWER
TPC
TPD
TPA
TPB
CR12
CR14
CR16
CR18
CR7
CR8
CR9
CR10
R37
TP3
AR1 FEEDBACK WINDING
PARALLEL WINDING
FEEDBACK GAIN
R16 25K 2W
R15 500 2W
LMU GAIN
R22 5.1K 5W
P23
J22

| REF DES. | DESCRIPTION |
|---|---|
| AR1 | MAGNETIC AMPLIFIER, FULL WAVE |
| C3 | CAPACITOR (SELECTED AT TEST) |
| C5 | CAPACITOR, FIXED |
| C6 | CAPACITOR, FIXED |
| C7 | CAPACITOR, FIXED |
| C9 | CAPACITOR, FIXED |
| CR2 | FULL WAVE BRIDGE RECTIFIER |
| CR3-CR6 | FULL WAVE BRIDGE RECTIFIER |
| CR7-CR10 | FULL WAVE BRIDGE RECTIFIER |
| CR11 | DIODE |
| CR12 | DIODE |
| CR13 | DIODE |
| CR14 | DIODE |
| CR15 | DIODE |
| CR16 | DIODE |
| CR17 | DIODE |
| CR18 | DIODE |
| J3 | CONNECTOR, RECEPTACLE |
| L1 | REACTOR |
| L2 | REACTOR |
| L3 | REACTOR |
| P1 | CONNECTOR, RECEPTACLE |
| P2 | CONNECTOR, RECEPTACLE |
| P5 | CONNECTOR, RECEPTACLE |
| Q1 | TRANSISTOR |
| Q2 | TRANSISTOR |
| R1 | RESISTOR, FIXED |
| R1A | RESISTOR, FIXED |
| R2 | RESISTOR, ADJUSTABLE |
| R4 | RESISTOR, FIXED |
| R5 | RESISTOR, FIXED |
| R8 | RESISTOR, FIXED |
| R10 | RESISTOR, ADJUSTABLE |
| R11 | RESISTOR, ADJUSTABLE |
| R12 | RESISTOR, ADJUSTABLE |
| R14 | RESISTOR, ADJUSTABLE |
| R15 | RESISTOR, VARIABLE |
| R16 | RESISTOR, VARIABLE |
| R18 | RESISTOR, VARIABLE |
| R20 | RESISTOR, FIXED |
| R22 | RESISTOR, FIXED |
| R23 | RESISTOR, FIXED |
| R37 | RESISTOR, FIXED |
| R38 | RESISTOR, FIXED |
| T1 | TRANSFORMER |
| T2 | TRANSFORMER |
| TP1 | CONNECTOR, TEST JACK |
| TP2 | CONNECTOR, TEST JACK |
| TP3 | CONNECTOR, TEST JACK |
| TP4 | CONNECTOR, TEST JACK |
| TPA | CONNECTOR, TEST JACK |
| TPB | CONNECTOR, TEST JACK |
| TPC | CONNECTOR, TEST JACK |
| TPD | CONNECTOR, TEST JACK |

ME 6115-545-34/1-5

**Figure 1-5. Schematic Diagram Electric Governor Control Unit, (Mode II, Class 1) Sets**

| REF. DES. | DESCRIPTION |
|---|---|
| A7 | CURRENT TRANSFORMER LOAD RESISTOR ASSEMBLY |
| K2 | OVER VOLTAGE RELAY |
| K13 | SHORT CIRCUIT RELAY |
| K14 | OVERLOAD RELAY |
| K15 | REVERSE POWER RELAY |
| R23 | RESISTOR, 7.5 OHMS, 20 W |
| R24 | RESISTOR, 7.5 OHMS, 20 W |
| R25 | RESISTOR, 7.5 OHMS, 20 W |
| TB105 | TERMINAL BOARD |
| TB107 | TERMINAL BOARD |

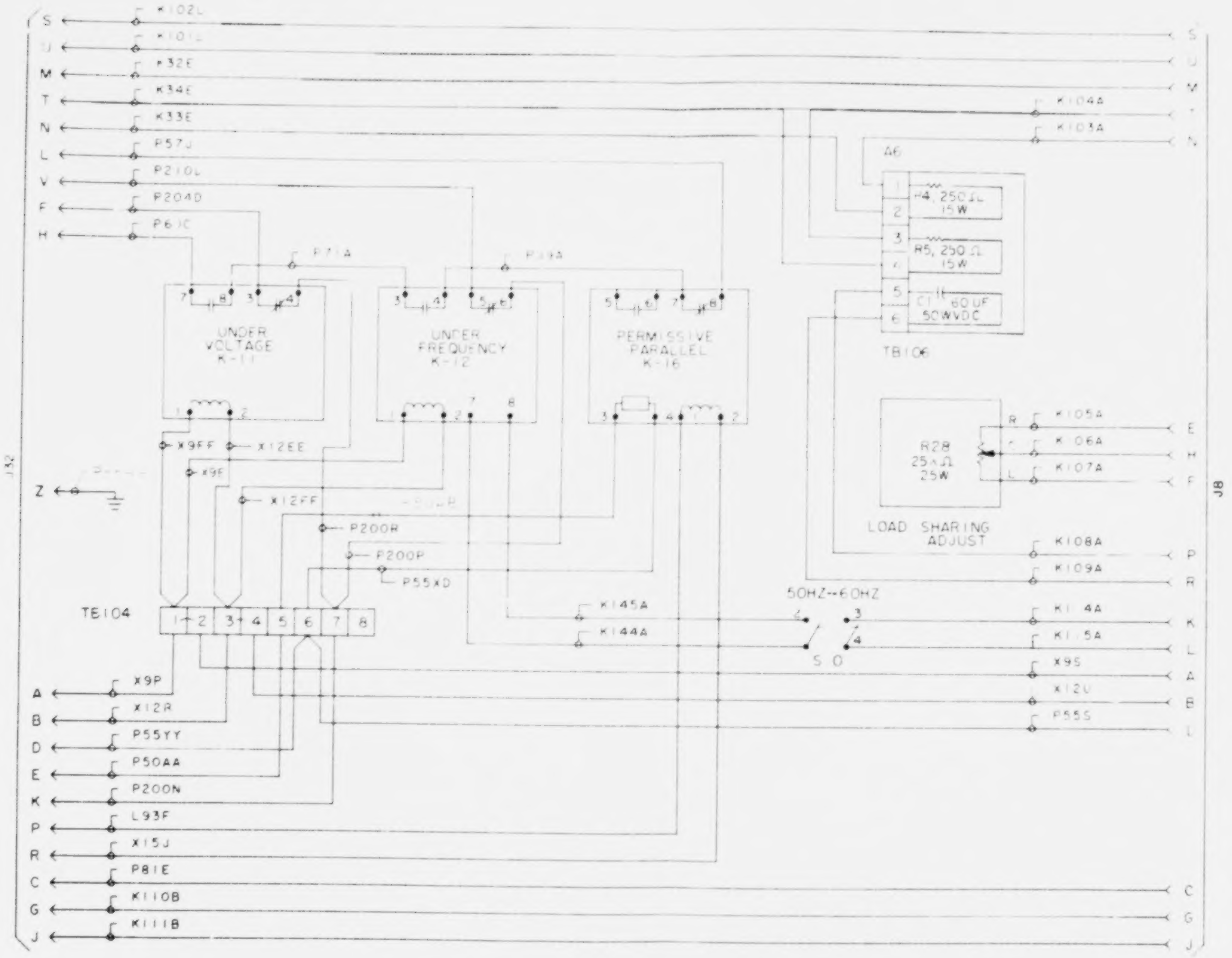

J51
A B C
P58B
P50X
P206D
D E
P205D
P60B
P61A
a b F
P63A
P62J
P203D
G H
P209D
P62H
NO NO NC NC
X115B
X116B
X117B
OVERVOLTAGE K2
REVERSE K15 POWER
SHORT CIRCUIT K13
OVERLOAD K14
R25 7.5Ω,20W
R24 7.5Ω,20W
R23 7.5Ω,20W
A7
TB107
X115C
X116C
X117C
D24F
K102G
K101G
X115A
P200X
P55JJ
P200Y
P200V
P200T
X9V
X12F
P50GG
P50W
P55KL
X17B
X18B
X19B
D24E
X117A
X116A
K102H
K101H
D24H
P55AX
X8VV
X7VV
TB-105
1 2 3 4 5 6 7 8 9 10
X9U
X12P
P50V
P55L
K102E
K101E
P200S
J K L M N X P
T U V W R S d
(J51)
X9T
X12X
X12V
X12DD
D G F E S N B A
K L M C
J4

NOTES

1 X115A INDICATES WIRE NUMBER

ME 6115-545-34/1-6 C1

Figure 1-6. Wiring Schematic Diagram, Tactical Relay Assembly


J32
S
U
M
T
N
L
V
F
H
K102L
K101L
P32E
K34E
K33E
P57J
P210L
P204D
P61C
P71A
P19A
UNDER VOLTAGE K-11
UNDER FREQUENCY K-12
PERMISSIVE PARALLEL K-16
X9FF
X12EE
X9F
X12FF
P200R
P200P
P55XD
Z
TE104
1
2
3
4
5
6
7
8
A
B
D
E
K
P
R
C
G
J
X9P
X12R
P55YY
P50AA
P200N
L93F
X15J
P81E
K110B
K111B
A6
R4, 250 Ω 15W
R5, 250 Ω 15W
C1 60 UF 50WVDC
TB106
K104A
K103A
R28 25 kΩ 25W
LOAD SHARING ADJUST
K105A
K106A
K107A
K108A
K109A
K145A
K144A
50HZ→60HZ
S10
K114A
K115A
X9S
X12U
P55S
J8

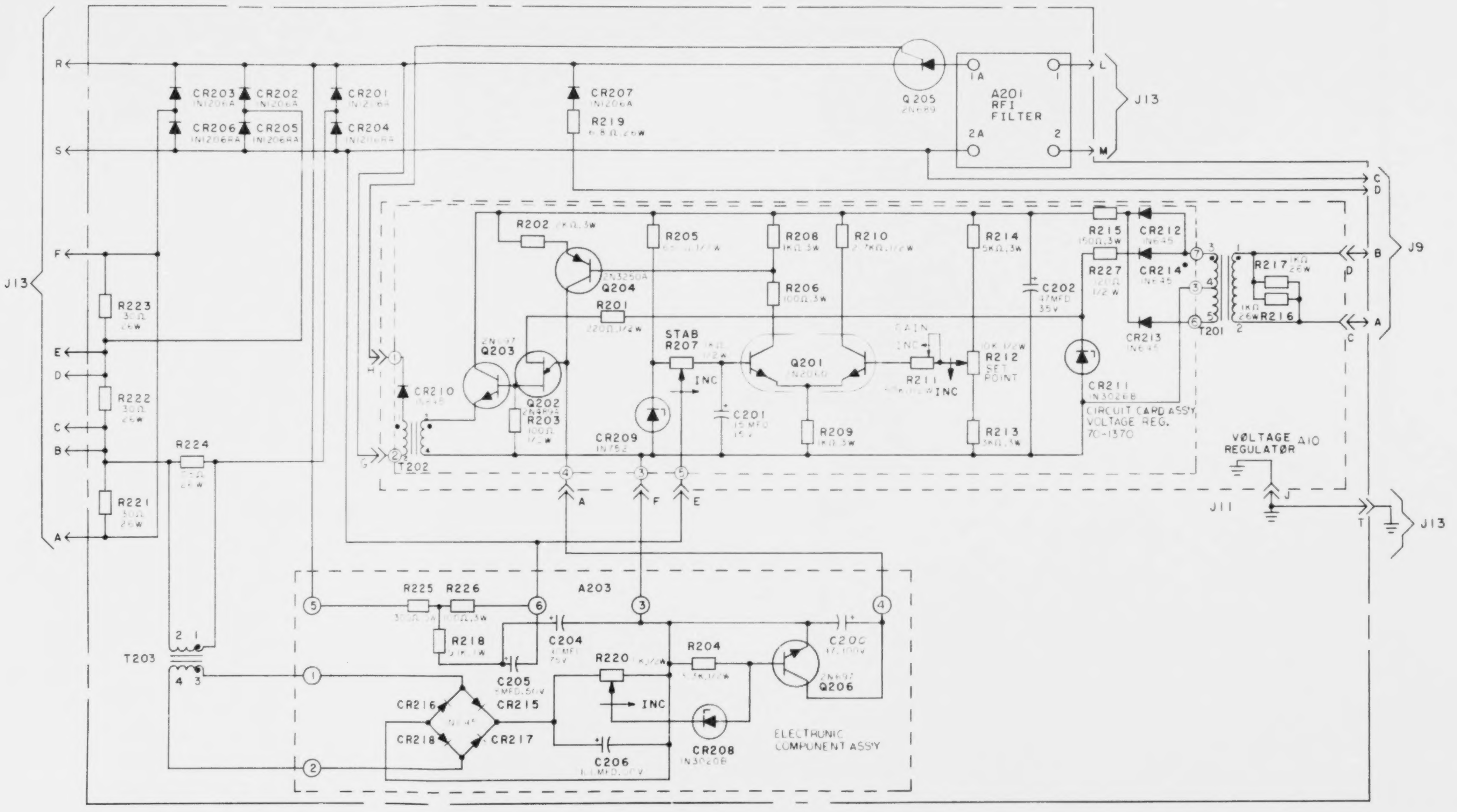
NOTES

⌀— 100P REPRESENTS WIRE NUMBER

| REF. DES | DESCRIPTION |
|---|---|
| A6 | RESISTOR ASSEMBLY GOVERNOR |
| C1 | CAPACITOR 60UF |
| K11 | UNDER VOLTAGE RELAY |
| K12 | UNDER FREQUENCY RELAY |
| K16 | PERMISSIVE PARALLELING RELAY |
| R4 | RESISTOR 250 OHMS |
| R5 | RESISTOR 250 OHMS |
| R28 | LOAD SHARING ADJUST POTENTIOMETER SAT |
| S10 | 50 60 HZ UNDER FREQUENCY SELECTOR SWITCH |
| TB104 | TERMINAL BOARD |
| TB106 | TERMINAL BOARD |

ME 6115-545-34/1-7 C1

Figure 1-7. Wiring Schematic Diagram, Precise Relay Assembly, (Class I, Mode I) Sets


R
S
F
E
D
C
B
A
J13
CR203 IN1206A
CR202 IN1206A
CR206 IN1206RA
CR205 IN1206RA
CR201 IN1206A
CR204 IN1206RA
CR207 IN1206A
R219 6.8Ω,26W
Q205 2N689
A201 RFI FILTER
1A
1
2A
2
L
M
J13
C
D
J9
B
A
R223 30Ω 26W
R222 30Ω 26W
R221 30Ω 26W
R224 25Ω 26W
R202 2KΩ,3W
Q204 2N3250A
R201 220Ω,1/2W
2N697 Q203
Q202 2N4891
R203 100Ω 1/2W
CR210 IN648
T202
H
G
R205
R208 1KΩ,3W
R206 100Ω,3W
R210 2.7KΩ,1/2W
R214 5KΩ,3W
C202 47MFD 35V
STAB R207 1KΩ 1/2W
INC
Q201 IN2060
GAIN
INC
R211
INC
R212 10K 1/2W SET POINT
C201 15MFD 15V
CR209 IN752
R209 1KΩ,3W
R213 3KΩ,3W
CR211 IN3026B
R215 150Ω,3W
R227 120Ω 1/2W
CR212 IN645
CR214 IN645
CR213 IN645
T201
R217 1KΩ 26W
R216 1KΩ 26W
CIRCUIT CARD ASS'Y VOLTAGE REG. 70-1370
VØLTAGE REGULATØR A10
J11
J
T
J13
A
F
E
A203
R225 30Ω,3W
R226 100Ω,3W
R218 51K,1W
C204 40MFD 75V
C205 5MFD,50V
R220 1K,1/2W
R204 5.5K,1/2W
C206 47,100V
Q206 2N697
CR216
CR215
CR218
CR217
IN645
C206 1.1MFD,50V
CR208 IN3020B
INC
ELECTRONIC COMPONENT ASS'Y
T203
2 1
4 3
1
2
3
4
5
6

| REF. DES. | DESCRIPTION |
|---|---|
| A10 | VOLTAGE REGULATOR |
| A201 | R. F. I. FILTER |
| A203 | ELECTRONIC COMPONENT ASSEMBLY |
| C200 | CAPACITOR |
| C201 | CAPACITOR |
| C202 | CAPACITOR |
| C204 | CAPACITOR |
| C205 | CAPACITOR |
| C206 | CAPACITOR |
| CR201 | DIODE |
| CR202 | DIODE |
| CR203 | DIODE |
| CR204 | DIODE |
| CR205 | DIODE |
| CR206 | DIODE |
| CR207 | DIODE |
| CR208 | DIODE, ZENER |
| CR209 | DIODE, ZENER |
| CR210 | DIODE |
| CR211 | DIODE, ZENER |
| CR212 | DIODE |
| CR213 | DIODE |
| CR214 | DIODE |
| CR215 | DIODE |
| CR216 | DIODE |
| CR217 | DIODE |
| CR218 | DIODE |
| Q201 | TRANSISTOR, DUAL |
| Q202 | TRANSISTOR, UNI-JUNCTION |
| Q203 | TRANSISTOR |
| Q204 | TRANSISTOR |
| Q205 | SILICON CONTROLLED RECTIFIER |
| Q206 | TRANSISTOR |
| R201 | RESISTOR, FIXED |
| R202 | RESISTOR, FIXED |
| R203 | RESISTOR, FIXED |
| R204 | RESISTOR, FIXED |
| R205 | RESISTOR, FIXED |
| R206 | RESISTOR, FIXED |
| R207 | RESISTOR, VARIABLE |
| R208 | RESISTOR, FIXED |
| R209 | RESISTOR, FIXED |
| R210 | RESISTOR, FIXED |
| R211 | RESISTOR, FIXED |
| R212 | RESISTOR, VARIABLE |
| R213 | RESISTOR, FIXED |
| R214 | RESISTOR, FIXED |
| R215 | RESISTOR, FIXED |
| R216 | RESISTOR, FIXED |
| R217 | RESISTOR, FIXED |
| R218 | RESISTOR, FIXED |
| R219 | RESISTOR, FIXED |
| R220 | RESISTOR, VARIABLE |
| R221 | RESISTOR, FIXED |
| R222 | RESISTOR, FIXED |
| R223 | RESISTOR, FIXED |
| R224 | RESISTOR, FIXED |
| R225 | RESISTOR, FIXED |
| R226 | RESISTOR, FIXED |
| R227 | RESISTOR, FIXED |
| T201 | TRANSFORMER |
| T202 | TRANSFORMER |
| T203 | TRANSFORMER |

ME 6115-545-34/1-8 C1

Figure 1-8. Schematic Diagram, Excitation System Assembly

| REF. DES. | DESCRIPTION |
|---|---|
| CR201-CR203 AND CR207 | DIODE MODULE (HALF OF 3 PHASE FULL WAVE RECTIFIER AND SCR EXTERNAL GATE ISOLATION DIODE) |
| CR204-CR206 | DIODE MODULE (HALF OF 3 PHASE FULL WAVE RECTIFIER) |
| R219 | RESISTOR, FIXED |
| R221 | RESISTOR, FIXED |
| R222 | RESISTOR, FIXED |
| R223 | RESISTOR, FIXED |
| R224 | RESISTOR, FIXED |
| RF1 | RADIO FREQUENCY, INTERFERENCE FILTER |
| SCR | SILICON CONTROLLED RECTIFIER |
| T203 | TRANSFORMER |
| TB201 | TERMINAL BLOCK |
| TB203 | TERMINAL BLOCK |

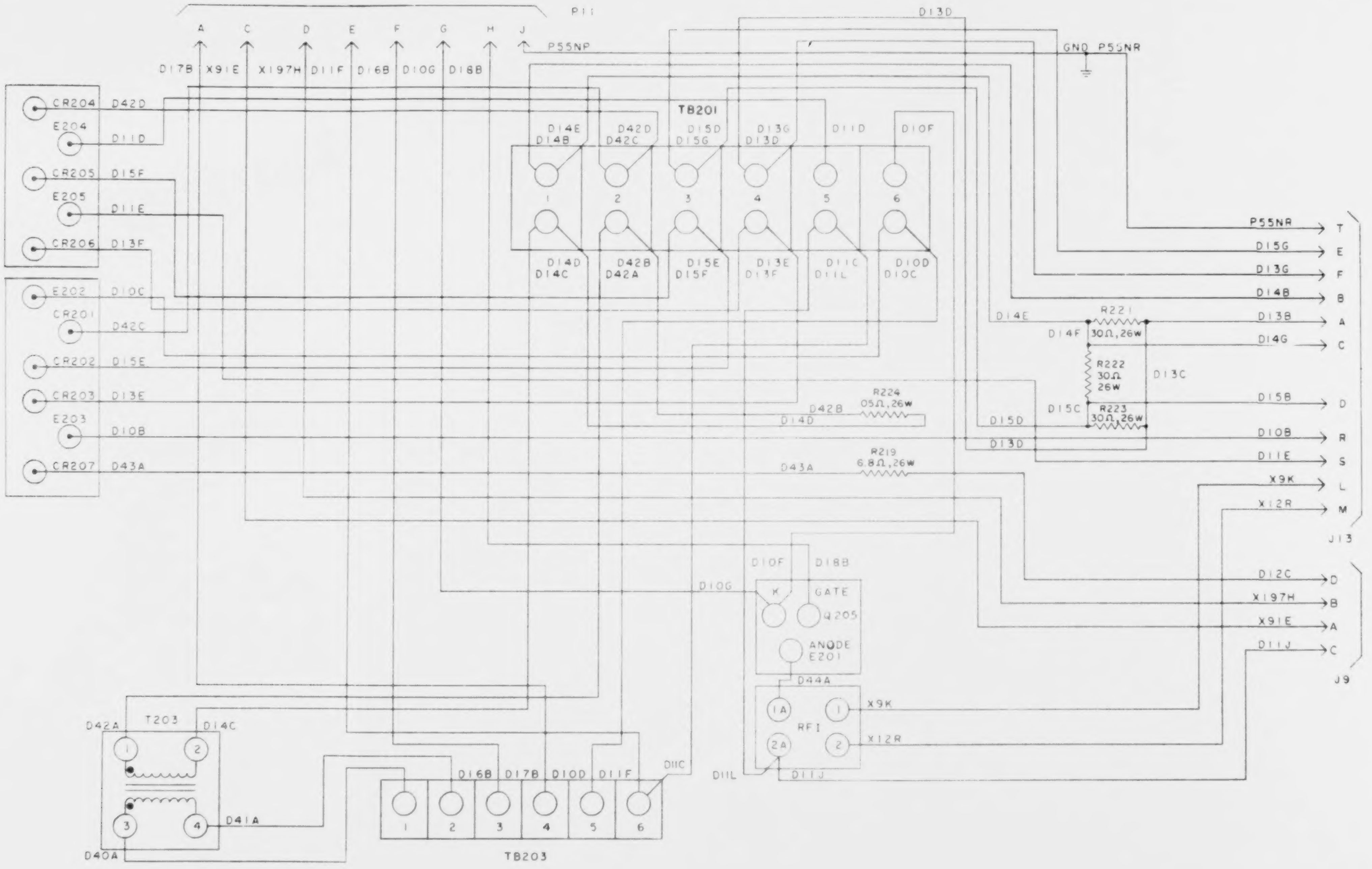
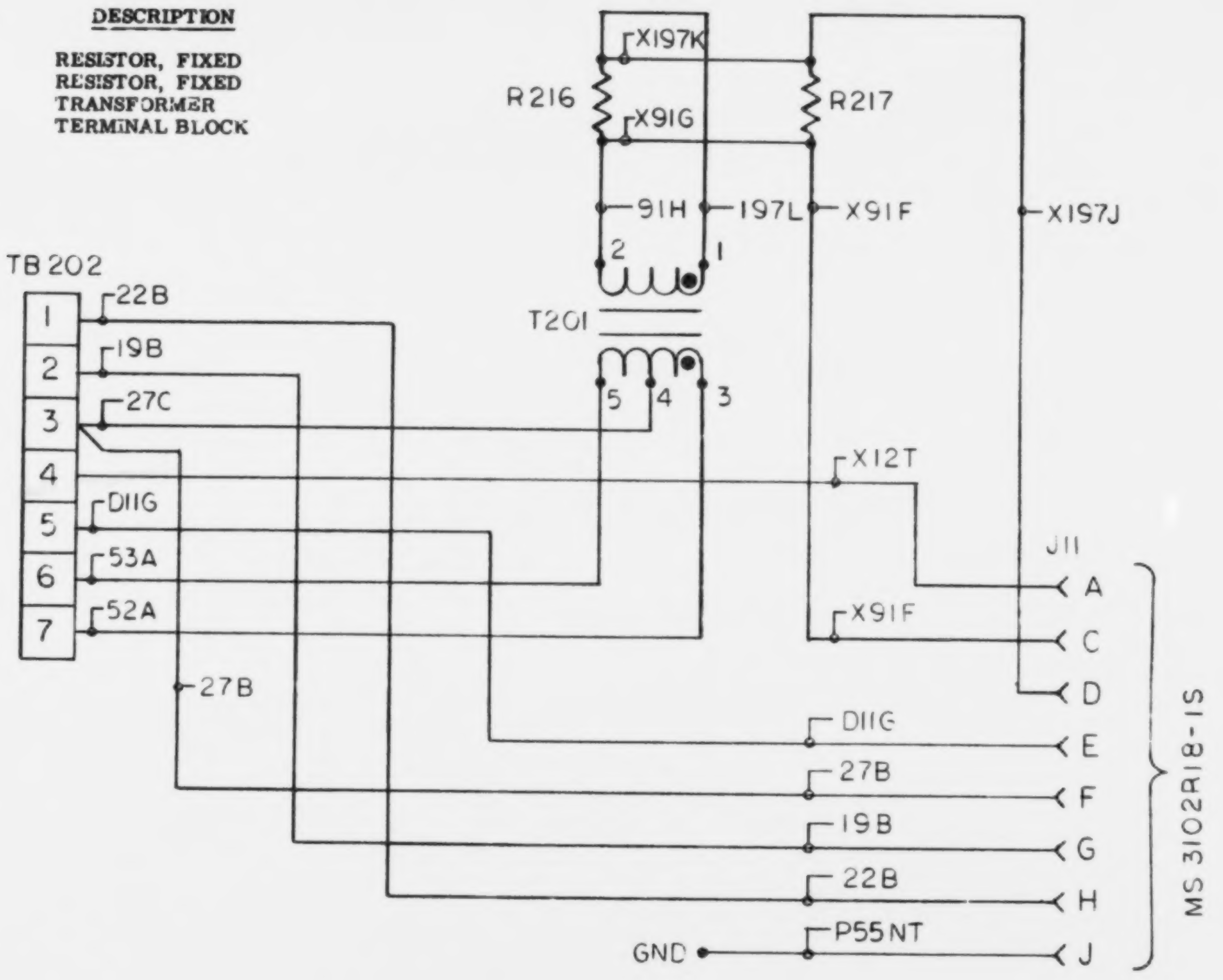

P11
A
C
D
E
F
G
H
J
P55NP
D17B
X91E
X197H
D11F
D16B
D10G
D18B
D13D
GND
P55NR
CR204
D42D
E204
D11D
CR205
D15F
E205
D11E
CR206
D13F
E202
D10C
CR201
D42C
CR202
D15E
CR203
D13E
E203
D10B
CR207
D43A
TB201
D14E
D14B
D42D
D42C
D15D
D15G
D13G
D13D
D11D
D10F
1
2
3
4
5
6
D14D
D14C
D42B
D42A
D15E
D15F
D13E
D13F
D11C
D11L
D10D
D10C
P55NR T
D15G E
D13G F
D14B B
D13B A
D14G C
D15B D
D10B R
D11E S
X9K L
X12R M
J13
D14E
D14F
R221
30Ω,26w
R222
30Ω
26w
D13C
D15C
R223
30Ω,26w
D15D
D13D
R224
05Ω,26w
D42B
D14D
R219
6.8Ω,26w
D43A
D12C D
X197H B
X91E A
D11J C
J9
D10F
D18B
D10G
K
GATE
Q205
ANODE
E201
D44A
1A
1
RF1
2A
2
X9K
X12R
D11L
D11J
D11C
D42A
T203
D14C
1
2
3
4
D41A
D40A
D16B
D17B
D10D
D11F
1
2
3
4
5
6
TB203
ME 6115-545-34/1-9 C1

Figure 1-9. Wiring Diagram, Excitation System Assembly

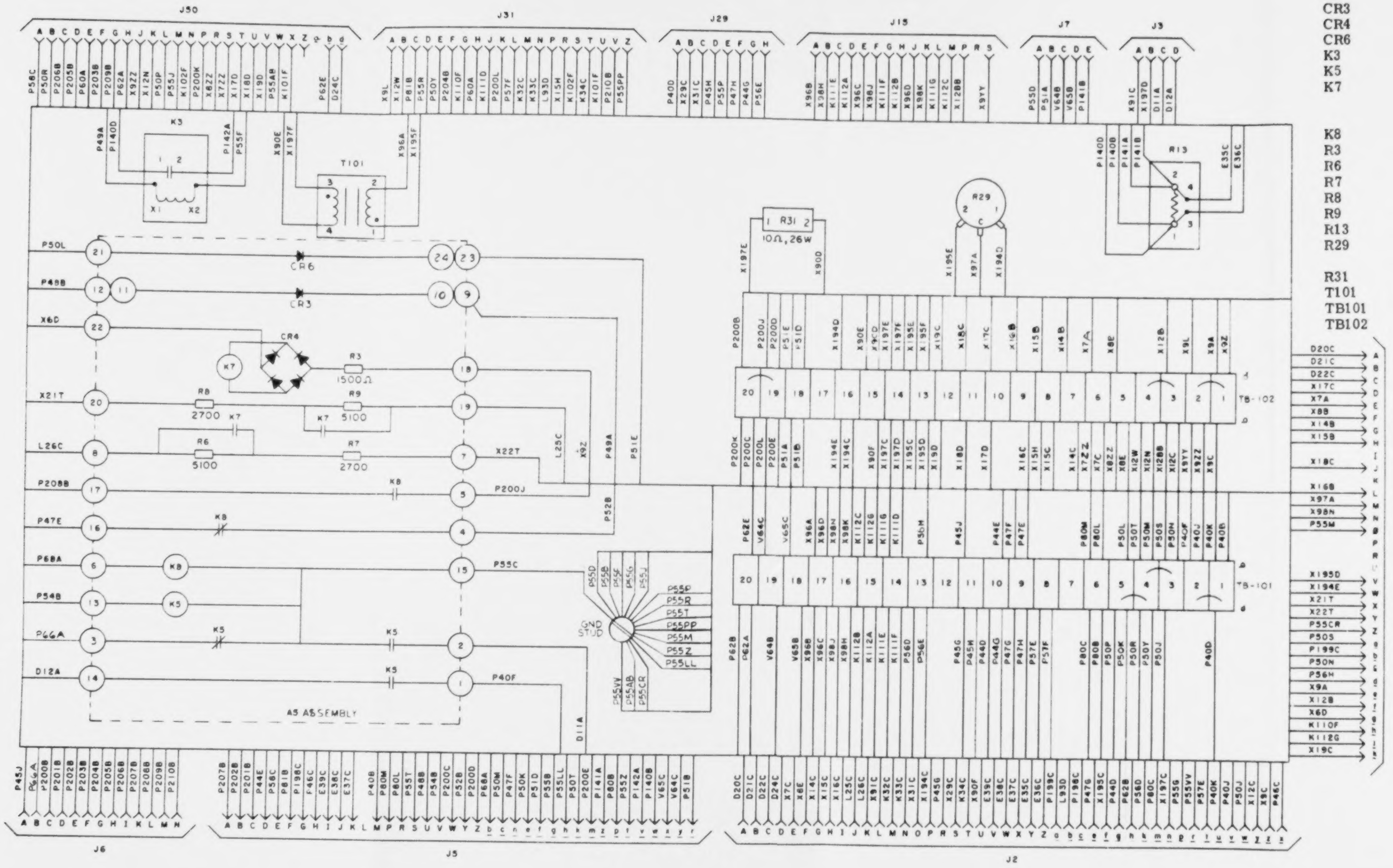
| REF. DES | DESCRIPTION |
|---|---|
| R216 | RESISTOR, FIXED |
| R217 | RESISTOR, FIXED |
| T201 | TRANSFORMER |
| TB202 | TERMINAL BLOCK |


R216
X197K
X91G
R217
91H
197L
X91F
X197J
2
1
T201
5
4
3
TB 202
1
2
3
4
5
6
7
22B
19B
27C
D11G
53A
52A
27B
X12T
J11
A
C
D
E
F
G
H
J
X91F
D11G
27B
19B
22B
P55NT
GND
MS 3102R18-1S

ME 6115-545-34/1-10

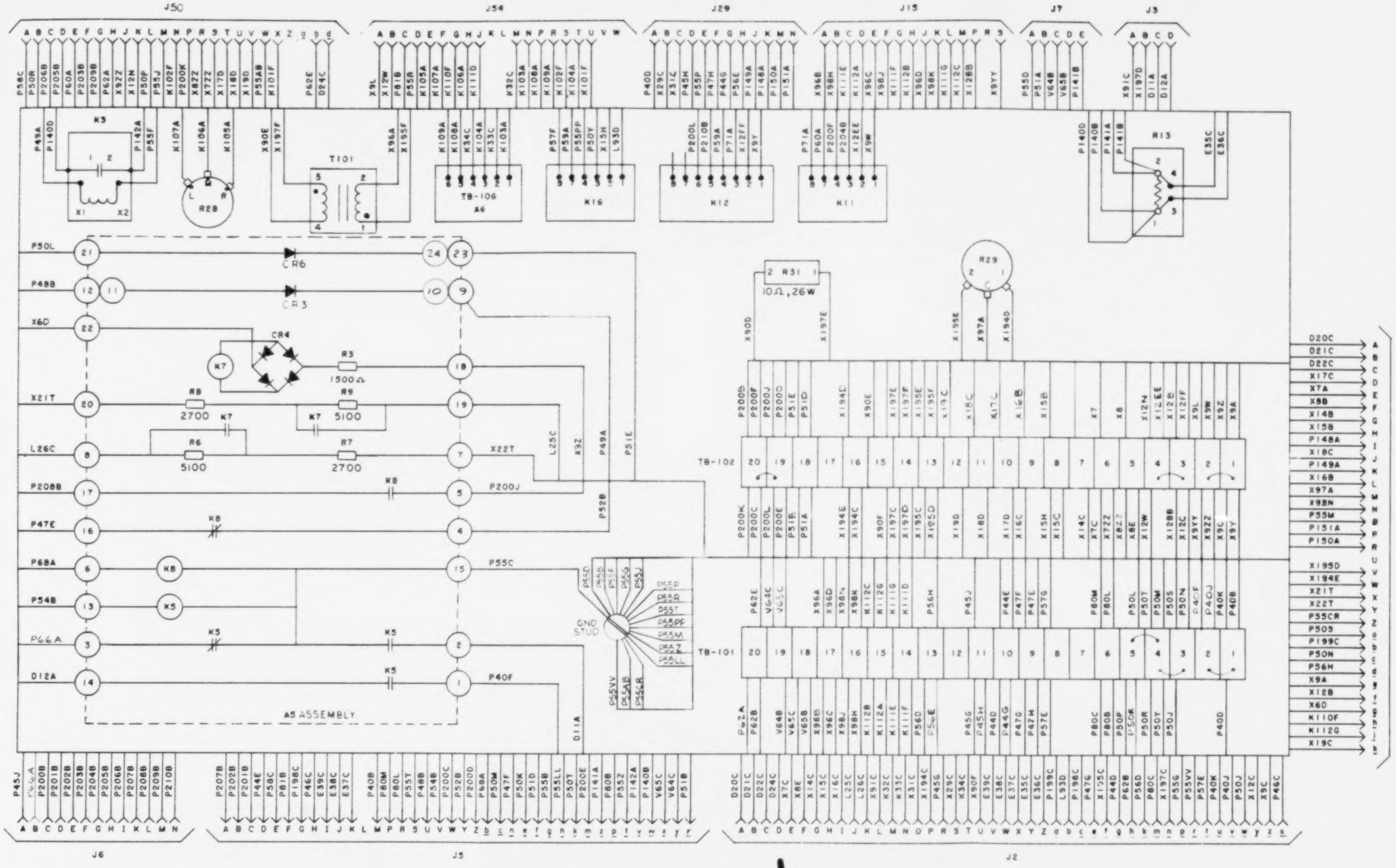
Figure 1-10. Wiring Schematic Diagram, Voltage Regulator

| REF. DES. | DESCRIPTION |
|---|---|
| A5 | RELAY ASSEMBLY |
| CR3 | BLOCKING DIODE |
| CR4 | FULL WAVE RECTIFIER |
| CR6 | BLOCKING DIODE |
| K3 | RELAY, CRANK |
| K5 | RELAY, FIELD FLASH |
| K7 | RELAY, PARALLELING LIGHTS, VOLTAGE SENSOR |
| K8 | RELAY, FUEL LEVEL |
| R3 | RESISTOR, FIXED |
| R6 | RESISTOR, FIXED |
| R7 | RESISTOR, FIXED |
| R8 | RESISTOR, FIXED |
| R9 | RESISTOR, FIXED |
| R13 | RESISTOR, FIXED |
| R29 | RHEOSTAT, REACTIVE CURRENT |
| R31 | RESISTOR, FIXED |
| T101 | TRANSFORMER |
| TB101 | TERMINAL BOARD |
| TB102 | TERMINAL BOARD |


J50
J31
J29
J15
J7
J3
K3
T101
R31
10Ω, 26W
R29
R13
CR6
CR3
CR4
R3
1500Ω
R8
2700
R9
5100
R6
5100
R7
2700
K7
K8
K5
TB-102
TB-101
GND STUD
A5 ASSEMBLY
J6
J5
J2
J10

ME 6115-545-34/1-11 C1

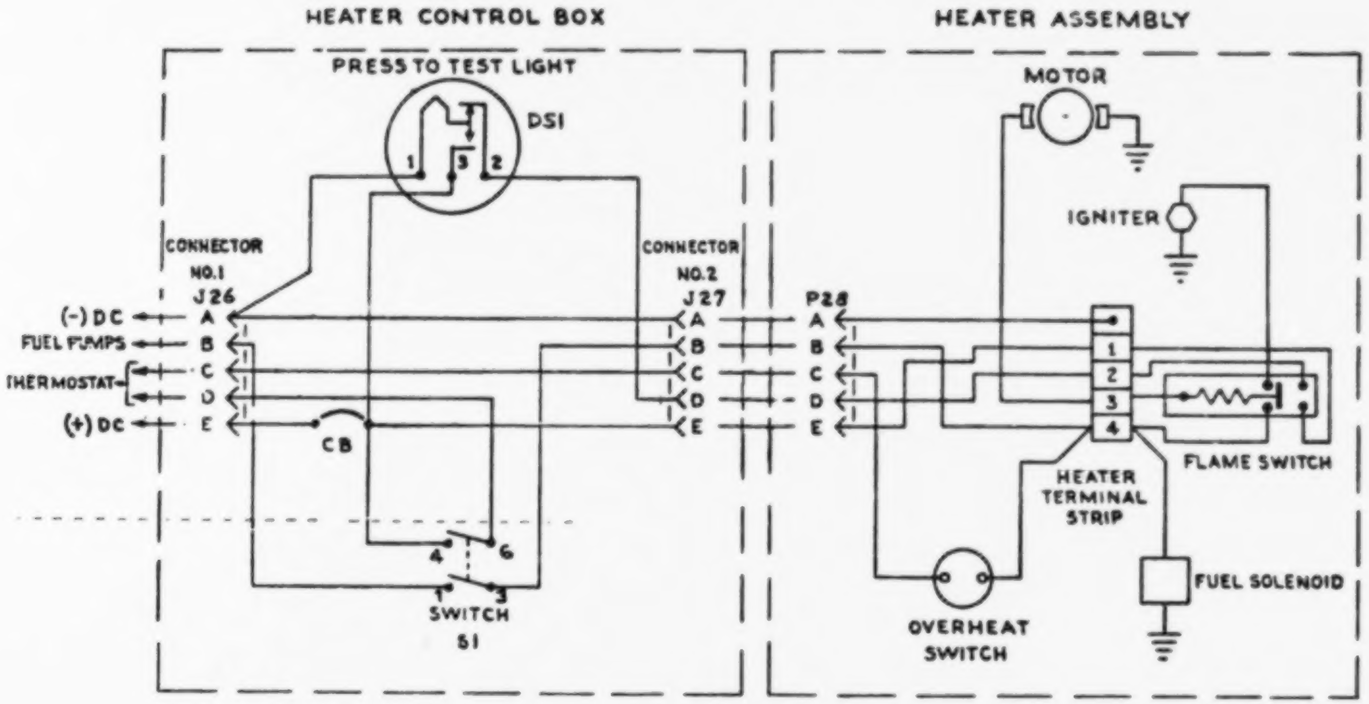
Figure 1-11. Wiring Schematic Diagram , Special Relay Assembly, (Mode I) Sets


J50
J54
J29
J15
J7
J3
K3
T101
R28
TB-106
A6
K16
K12
K11
R13
R31
10Ω, 26W
R29
CR6
CR3
CR4
K7
R3
1500Ω
R8
2700
R9
5100
R6
5100
R7
2700
K8
K5
GND STUD
A5 ASSEMBLY
TB-102
TB-101
J10
J6
J5
J2

| REF. DES. | DESCRIPTION |
|---|---|
| A5 | ASSEMBLY |
| A6 | RESISTOR ASSEMBLY GOVERNOR |
| CR3 | BLOCKING DIODE |
| CR4 | FULL WAVE RECTIFIER |
| CR6 | BLOCKING DIODE |
| K3 | RELAY, CRANK |
| K5 | RELAY FIELD FLASH |
| K7 | RELAY, PARALLELING LIGHTS AND VOLTAGE SENSOR |
| K8 | RELAY, FUEL LEVEL |
| K11 | RELAY, UNDER VOLTAGE |
| K12 | RELAY, UNDER FREQUENCY |
| K16 | RELAY, PERMISSIVE PARALLELING |
| R3 | RESISTOR, FIXED |
| R6 | RESISTOR, FIXED |
| R7 | RESISTOR, FIXED |
| R8 | RESISTOR, FIXED |
| R9 | RESISTOR, FIXED |
| R13 | RESISTOR, FIXED |
| R28 | RHEOSTAT, LOADING SHARING |
| R29 | RHEOSTAT, REACTIVE CURRENT |
| R31 | RESISTOR, FIXED |
| T101 | TRANSFORMER |
| TB101 | TERMINAL BLOCK |
| TB102 | TERMINAL BLOCK |
| TB106 | TERMINAL BOARD |

ME 6115-545-34/1-12 C6

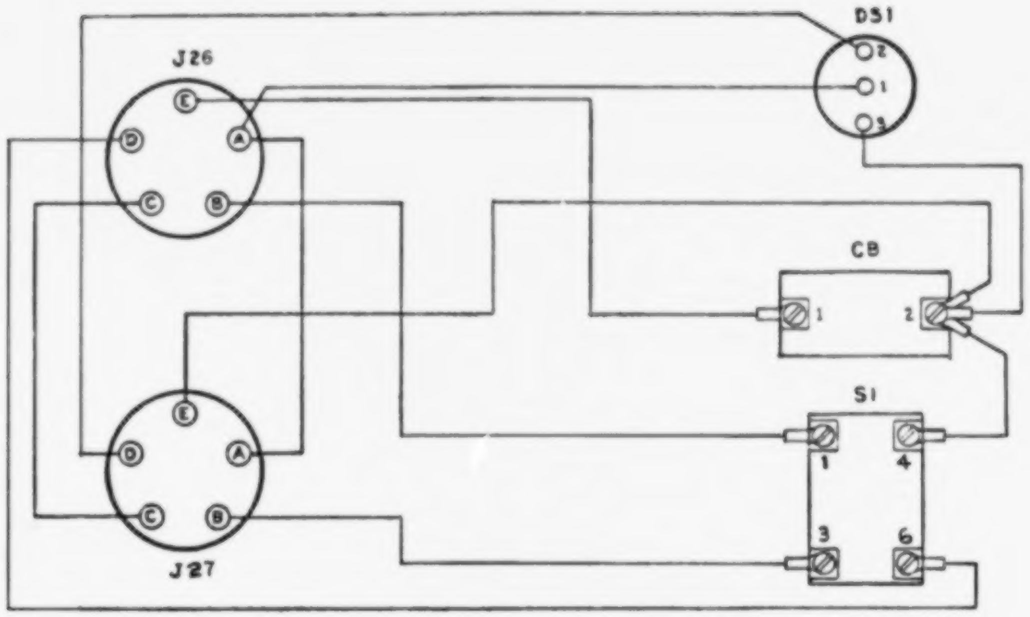
Figure 1-12. Wiring Schematic Diagram, Special Relay Assembly, (Mode II) Set


HEATER CONTROL BOX
HEATER ASSEMBLY
PRESS TO TEST LIGHT
DS1
1
3
2
CONNECTOR NO.1
J26
(-) DC
FUEL PUMPS
THERMOSTAT
(+) DC
A
B
C
D
E
CB
4
6
1
3
SWITCH
S1
CONNECTOR NO.2
J27
P28
MOTOR
IGNITER
1
2
3
4
FLAME SWITCH
HEATER TERMINAL STRIP
FUEL SOLENOID
OVERHEAT SWITCH

| REF. DES. | DESCRIPTION |
|---|---|
| CB | CIRCUIT BREAKER |
| DS1 | INDICATOR LAMP |
| S1 | SWITCH |

ME 6115-545-34/1-13

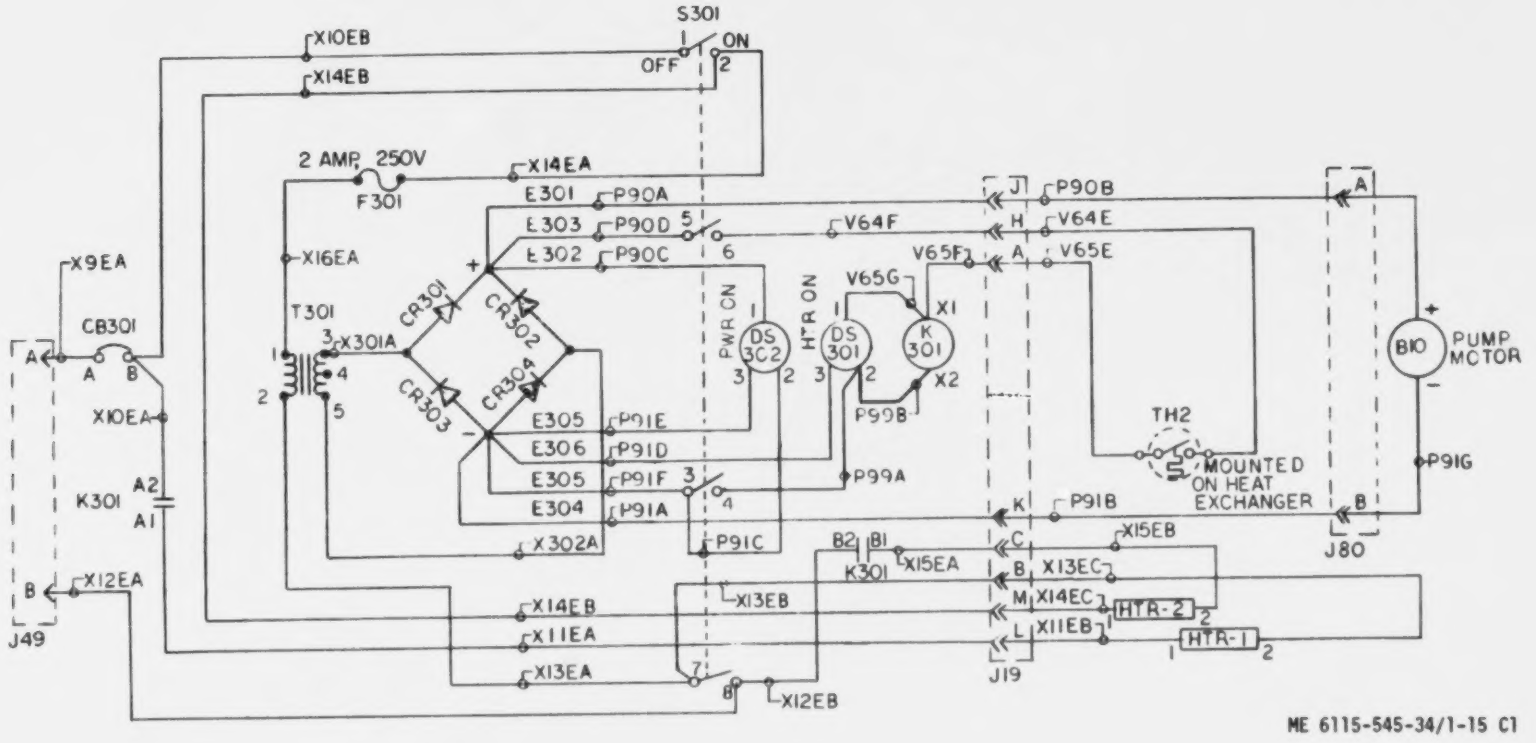
Figure 1-13. Schematic Diagram, Fuel Burning Winterization Kit


DS1
2
1
3
J26
E
A
D
C
B
CB
1
2
S1
1
4
3
6
E
D
A
C
B
J27

| REF. DES. | DESCRIPTION |
|---|---|
| CB | CIRCUIT BREAKER |
| DS1 | INDICATOR (WITH PRESS TO TEST FEATURE) |
| S1 | SWITCH |

ME 6115-545-34/1-14 C1

Figure 1-14. Wiring Diagram, Fuel Burning Winterization Kit


S301
ON
OFF
X10EB
X14EB
2 AMP, 250V
F301
X14EA
E301
P90A
E303
P90D
E302
P90C
X9EA
X16EA
CB301
J49
T301
X301A
CR301
CR302
CR303
CR304
X10EA
K301
A2
A1
X12EA
E305
P91E
E306
P91D
E305
P91F
E304
P91A
X302A
P91C
PWR ON
HTR ON
DS 3C2
DS 301
K 301
V65G
V64F
V65F
X1
X2
P99B
P99A
J
H
A
P90B
V64E
V65E
TH2
MOUNTED ON HEAT EXCHANGER
K
P91B
C
X15EB
B2
B1
K301
X15EA
B
X13EC
M
X14EC
HTR-2
L
X11EB
HTR-1
J19
X13EB
X14EB
X11EA
X13EA
X12EB
B10
PUMP MOTOR
P91G
J80
ME 6115-545-34/1-15 C1

| REF. DES. | DESCRIPTION | REF. DES. | DESCRIPTION |
|---|---|---|---|
| B10 | PUMP MOTOR | HTR-1 | HEATER |
| CB301 | CIRCUIT BREAKER | HTR-2 | HEATER |
| CR301-CR304 | FULL WAVE DIODE BRIDGE | K301 | CONTACTOR |
| DS301 | INDICATOR LAMP (HTR ON) | S301 | SWITCH, CONTROL |
| DS302 | INDICATOR LAMP(PWR ON) | T301 | TRANSFORMER |
| F301 | FUSE, 2 AMP, 250 V | TH2 | THERMOSTATIC SWITCH |

Figure 1-15. Schematic Wiring Diagram Electric Winterization Kit

Table 1-2. Repair and Replacement Standards

| Components | Manufacturer's dimensions and tolerances in inches |  | Maximum allowable wear and clearance |
|---|---|---|---|
|  | Minimum | Maximum |  |
| ENGINE |  |  |  |
| Cylinder sleeves: |  |  |  |
| Inside diameter at top of ring travel | 4.2495 | 4.2510 | 0.005 |
| Diameter of cylinder sleeve at machined area just below flange | 4.811 | 4.813 | 0.002 |
| Diameter of cylinder sleeve at packing ring location | 4.749 | 4.751 | 0.002 |
| Sleeve flange outside diameter | 4.998 | 5.002 | 0.004 |
| Cylinder block-to-sleeve clearance at sleeve lower diameter | 0.001 | 0.005 | 0.004 |
| Cylinder block-to-sleeve clearance at machined area just below flange | 0.0005 | 0.0045 | 0.004 |
| Cylinder block-to-sleeve clearance at sleeve flange | 0.004 | 0.013 | 0.009 |
| Clearance of piston skirt with sleeve | 0.0025 | 0.0050 | 0.003 |
| Fire wall height cylinder sleeve flange | 0.0445 | 0.0475 | 0.002 |
| Top surface of cylinder flange above cylinder block with sleeve installed | 0.002 | 0.005 | ---- |
| Flange height adjusting shims available | 0.005<br>0.010<br>0.015<br>0.020 |  |  |
| Allowable taper |  | 0.0015 |  |
| Allowable out-of-round (When installed) |  | 0.0015 |  |
| Cylinder block: |  |  |  |
| Counterbore diameter in cylinder block for cylinder sleeve flange | 5.006 | 5.011 | 0.005 |
| Depth of counterbore for cylinder sleeve flange | 0.3150 | 0.3165 | 0.0015 |
| Bore in cylinder block for cylinder sleeve-top | 4.8135 | 4.8155 | 0.002 |
| Bore in cylinder block for cylinder sleeve - bottom | 4.752 | 4.754 | 0.002 |
| Bore in cylinder block for camshaft bearings | 2.259 | 2.260 |  |
| Bearing bore in cylinder block for main bearings (without bearing), cap in place, and capscrews tightened to specified torque | 3.5607 | 3.5614 | --- |

Table 1-2. Repair and Replacement Standards - (Cont)

| Components | Manufacturer's dimensions and tolerances in inches | | Maximum allowable wear and clearance |
|---|---|---|---|
| | Minimum | Maximum | |
| Pistons: | | | |
| NOTE<br>Combustion chamber is in piston | | | |
| Combustion chamber bore | 2.998 | 3.002 | 0.004 |
| Combustion chamber depth | 0.592 | 0.596 | 0.004 |
| Length | 5.824 | 5.829 | 0.005 |
| Diameter between top and second ring groove | 4.225 | 4.229 | 0.004 |
| Diameter at bottom of skirt measured at right angle to piston pin | 4.246 | 4.247 | 0.003 |
| Bore for piston pin | 1.5014 | 1.5016 | 0.001 |
| Measurement from center of piston pin bore to top of piston | 3.142 | 3.146 | 0.004 |
| Clearance of piston skirt with sleeve | 0.0025 | 0.0050 | 0.003 |
| Piston pins: | | | |
| Type full (floating) | | | |
| Piston pin length | 3.606 | 3.616 | 0.005 |
| Diameter of pin | 1.5011 | 1.5013 | 0.0002 |
| Fit of pin in piston at room temperature | 0.0001 | 0.0005 loose | 0.0004 |
| Bore of connecting rod bushing | 1.5027 | 1.5032 | 0.001 |
| Piston pin to connecting rod bushing clearance | 0.0014 | 0.0021 | 0.002 |
| Piston rings: | | | |
| Gap between ends - fitted, 1st ring (chrome compression) | 0.013 | 0.027 | --- |
| 2nd and 3rd ring (compression) | 0.013 | 0.024 | --- |
| 4th ring (oil control) | 0.013 | 0.024 | --- |
| Clearance of rings in grooves | | | |
| 1st ring (chrome compression) | 0.0040 | 0.0060 | 0.005 |
| 2nd and 3rd ring (compression) | 0.0020 | 0.0040 | 0.002 |
| 4th ring (oil control) | 0.0005 | 0.003 | 0.0025 |
| NOTE<br>**Only standard size rings are available** | | | |

Table 1-2. Repair and Replacement Standards -(Cont)

| Components | Manufacturer's dimensions and tolerances in inches | | Maximum allowable wear and clearance |
|---|---|---|---|
| | Minimum | Maximum | |
| Crankshaft: | | | |
| Journal diameter for connecting rods | 2.7470 | 2.7485 | 0.002 |
| Journal diameter for main bearing | 3.2465 | 3.248 | 0.002 |
| Width between connecting rod journal checks | 1.562 | 1.565 | 0.003 |
| Width of main bearing journals | | | |
| Front | 2.147 | 2.167 | 0.020 |
| Intermediates | 1.685 | 1.689 | 0.004 |
| Center | 2.061 | 2.063 | 0.002 |
| Rear | 2.014 | 2.017 | 0.003 |
| Crankshaft end clearance | 0.007 | 0.013 | 0.008 |
| Separate type thrust flanges | Available in standard size and 0.005, 0.010, 0.015 oversize | | ---- |
| Crankshaft journals may be ground | 0.002, 0.010, 0.020 or 0.040 undersize | | ---- |
| Fit of crankshaft gear on crankshaft | 0.001 | 0.003 interference | |
| Main bearings: | | | |
| Bore of front, intermediate, center, and rear bearing (with capscrews tightened to specified torque) | 3.2499 | 3.2511 | 0.0038 |
| Diameter of crankshaft main bearing journals | 3.2465 | 3.248 | 0.002 |
| Bearing-to-journal clearance at front, intermediate, center, and rear bearings (with capscrews tightened to specified torque) | 0.0019 | 0.0046 | 0.0034 |
| Overall length of main bearings | | | |
| Front and Intermediate | 1.432 | 1.442 | 0.010 |
| Center | 1.682 | 1.692 | 0.010 |
| Rear | 1.682 | 1.692 | 0.010 |
| Undersize bearings available for service | 0.002, 0.010, 0.020 and 0.040 | | |

Table 1-2. Repair and Replacement Standards -(Cont)

| Components | Manufacturer's dimensions and tolerances in inches | | Maximum allowable wear and clearance |
|---|---|---|---|
| | Minimum | Maximum | |
| Main bearings: | | | |
| Separate type thrust flanges | Available in standard size and 0.005, 0.010, 0.015 oversize | | |
| Front, intermediate, center, and rear bearing wall thickness (standard bearings) | 0.1549 | 0.1554 | 0.0019 |
| Bearing bore in cylinder block (without bearing, cap in place, and capscrews tightened to specified torque) | 3.5607 | 3.5614 | ---- |
| Connecting rod bearings: | | | |
| Bore of bearing (with capscrews tightened to specified torque) | 2.7495 | 2.7510 | 0.0035 |
| Diameter of crankshaft connecting rod journals | 2.7470 | 2.7485 | 0.002 |
| Connecting rod bearing-to-journal clearance (with capscrews tightened to specified torque) | 0.001 | 0.0035 | 0.0045 |
| Overall length of connecting rod bearings | 1.195 | 1.205 | 0.010 |
| Undersize bearings available for service | 0.002<br>0.010<br>0.020<br>0.040 | | ---- |
| Bearing wall thickness (standard bearing) | 0.10975 | 0.11025 | 0.00175 |
| Connecting rods: | | | |
| Connecting rod length (center-to-center) | 8.498 | 8.502 | --- |
| Bore of connecting rod bushing (finished bore) | 1.5027 | 1.5032 | 0.001 |
| Bearing bore (without bearing, cap in place, and capscrews tightened to specified torque) | 2.9700 | 2.9705 | ---- |
| Connecting rod bearing-to-crankshaft journal clearance (with capscrews tightened to specified torque) | 0.001 | 0.0035 | 0.0045 |
| Connecting rod width at lower end | 1.555 | 1.557 | 0.005 |
| Side clearance-to-crankshaft journal | 0.005 | 0.010 | 0.005 |

Table 1-2. Repair and Replacement Standards - (Cont)

| Components | Manufacturer's dimensions and tolerances in inches | | Maximum allowable wear and clearance |
|---|---|---|---|
| | Minimum | Maximum | |
| Connecting rods: | | | |
| Piston pin diameter | 1.5011 | 1.5013 | 0.0002 |
| Piston pin bushing length in connecting rod | 1.490 | 1.510 | 0.010 |
| Piston pin to connecting rod bushing clearance | 0.0014 | 0.0021 | 0.001 |
| Bore in connecting rod for piston pin bushing | 1.6250 | 1.6255 | 0.0005 |
| Exhaust valves: | | | |
| Valve lift (at valve) w/0.015 inch lash | | 0.4125 | --- |
| Valve lift (at cam) | | 0.285 | --- |
| Seat angle | | 30° | --- |
| Valve seat contact width | | 3/32 | 1/64 |
| Valve lash (cold) | | 0.018 | ---- |
| Valve lash (engine coolant at normal operating temperature) | | 0.015 | ---- |
| Head diameter | 1.646 | 1.656 | 0.010 |
| Overall length | | 6.017 | 0.010 |
| Stem diameter | 0.3705 | 0.3710 | 0.001 |
| Valve must be recessed (in head) | 0.053 | | |
| Exhaust and intake valve springs: | | | |
| Valve spring free length (spring only or spring w/damper) | 2-17/32 | approx | ---- |
| Valve spring length (valve closed) (spring only or spring w/damper) | | 2.237 | ---- |
| Valve spring length (valve open) (spring only or spring w/damper) | | 1.780 | |
| **Spring load at 2.237 length spring w/damper** | **40 lbs** | **46 lbs** | ---- |
| **Spring load at 2.237 length Spring only** | **38 lbs** | **42 lbs** | ---- |
| **Spring load at 1.780 length Spring w/damper** | **105 lb** | **115 lbs** | ---- |
| **Spring load at 1,780 length Spring only**<br>**NOTE**<br>**Install new spring when old spring is 5% below the low limit or 5% above the high limit.** | **95 lbs** | **105 lbs** | |

### Table 1-2. Repair and Replacement Standards -(Cont)

| Components | Manufacturer's dimensions and tolerances in inches | | Maximum allowable wear and clearance |
|---|---|---|---|
| | Minimum | Maximum | |
| Intake valves: | | | |
| Valve lift (at valve) w/0.015 inch lash | | 0.462 | ----- |
| Valve lift (at cam) | | 0.318 | ----- |
| Seat angle | | 30° | ----- |
| Valve seat contact width | | 3/32 | 1/64 |
| Valve lash (cold) | | 0.018 | ----- |
| Valve lash (engine coolant at normal operating temperatures | | 0.015 | ---- |
| Head diameter | 1.834 | 1.844 | 0.010 |
| Overall length | | 6.016 | 0.010 |
| Stem diameter | 0.3715 | 0.3720 | 0.001 |
| Valve must be recessed in head | 0.054 | | |
| Exhaust valve seat inserts: | | | |
| Seat angle | | 30° | ----- |
| Seat contact width | | 3/32 | 1/64 |
| Seat run-out | | 0.002 | ----- |
| Insert press fit | 0.001 | 0.003 | ----- |
| Insert outer diameter not installed | 1.667 | 1.668 | ----- |
| Bore in cylinder head for insert | 1.665 | 1.666 | ----- |
| Depth of counterbore in cylinder head for insert (from bottom deck of head) | 0.4735 | 0.4755 | 0.002 |
| Oversize insert | 0.005 | over standard | |
| Intake valve seat: | | | |
| Seat angle | | 30° | |
| Seat width | | 3/32 | 1/64 |
| Seat run-out | | 0.002 | ----- |
| Insert press fit | 0.001 | 0.003 | ----- |
| Insert outer diameter not installed | 1.811 | 1.812 | ----- |

**Table 1-2. Repair and Replacement Standards -(Cont)**

| Components | Manufacturer's dimensions and tolerances in inches | | Maximum allowable wear and clearance |
|---|---|---|---|
| | Minimum | Maximum | |
| Intake valve seat inserts: | | | |
| Bore in cylinder head for insert | 1.809 | 1.810 | ----- |
| Depth of counterbore in head for insert (from bottom deck of head) | 0.4585 | 0.4605 | 0.002 |
| Oversize insert | 0.005 | over standard | |
| Exhaust and intake valve guides: | | | |
| Length | -- | 2-7/8 | 0.010 |
| Inside diameter ream after assembly | -- | 0.3725 | ----- |
| Stem-to-guide clearance | | | |
| Exhaust | 0.0015 | 0.002 | 0.0035 |
| Intake | 0.0005 | 0.001 | 0.0025 |
| Guide stand-out from bottom of counterbore in cylinder head | | | |
| Exhaust | | 1-3/32 | ± 0.010 |
| Intake | | 25/32 | ± 0.010 |
| Rocker arms - with non-replaceable bushings: | | | |
| Bore of rocker arm bushing (finish bore) | 1.001 | 1.002 | 0.001 |
| Outside diameter of rocker arm shaft | 0.999 | 1.000 | 0.001 |
| Rocker arm shaft-to-rocker arm bushing clearance | 0.001 | 0.003 | 0.002 |
| Rocker arm ratio | | 1.5:1 | ----- |
| Camshaft: | | | |
| Bore of camshaft bearing (when installed) | 2.133 | 2.136 | 0.003 |
| Outside diameter of camshaft journals | 2.130 | 2.131 | 0.001 |
| Camshaft bearing-to-journal running clearance | 0.002 | 0.006 | 0.002 |
| Outside diameter of camshaft bearings | 2.263 | 2.265 | 0.002 |
| Bore in cylinder block for bearing | 2.259 | 2.260 | 0.001 |
| Fit of camshaft bearings in bore of cylinder block | 0.003 | 0.006 interference | 0.005 interference |

## Table 1-2. Repair and Replacement Standards - (Cont)

| Components | Manufacturer's dimensions and tolerances in inches | | Maximum allowable wear and clearance |
|---|---|---|---|
| | Minimum | Maximum | |
| Camshaft: | | | |
| Overall width of camshaft bearings | | | |
| front | --- | 1-3/8 | ----- |
| intermediates | --- | 1 | ----- |
| rear | -- | 1 | ----- |
| Camshaft end play | 0.0027 | 0.0083 | 0.0067 |
| Fit of camshaft gear on camshaft | 0.0015 | 0.003 interference | 0.0025 interference |
| Specified thickness of thrust collar | 0.204 | 0.206 | 0.006 |
| Valve lifters: | | | |
| Bore in cylinder block for valve lifter | 0.7495 | 0.7505 | 0.001 |
| Outside diameter of valve lifter stem | 0.7480 | 0.7485 | 0.0005 |
| Valve lifter to bore of cylinder block clearance | 0.001 | 0.0025 | 0.001 |
| Front gear train backlash: | | | |
| Crankshaft gear to camshaft gear | 0.0015 | 0.009 | 0.0075 |
| Crankshaft gear to idler gear | 0.0015 | 0.0085 | 0.0065 |
| Fuel pump drive gear to fuel pump driven gear | 0.002 | 0.0095 | 0.0075 |
| Camshaft gear to hydraulic pump gear | 0.003 | 0.011 | 0.008 |
| Water pump: | | | |
| Clearance - impeller to plate. Set w/0.15 feeler gauge | | | |
| Bearing | | | |
| Bearing outside diameter | 1.4995 | 1.5000 | 0.0005 |
| Bore in water pump body (for bearing) | 1.498 | 1.499 | 0.005 |
| Fit - Bearing outside diameter to body | 0.0005 | 0.002 interference | 0.0015 interference |
| Impeller | | | |
| Bore in impeller for shaft | 0.6225 | 0.6235 | 0.0005 |
| Shaft diameter | 0.6262 | 0.6267 | 0.0005 |
| Fit - Shaft diameter to impeller bore | 0.0027 | 0.0042 | 0.003 |

Table 1-2. Repair and Replacement Standards - (Cont)

| Components | Manufacturer's dimensions and tolerances in inches | | Maximum allowable wear and clearance |
|---|---|---|---|
| | Minimum | Maximum | |
| Water pump: | | | |
| Hub - for water pump pulley | | | |
| Bore in hub for shaft | 0.7435 | 0.7445 | 0.0005 |
| Shaft diameter | 0.7460 | 0.7465 | 0.0005 |
| Fit - Shaft diameter to hub bore | 0.0015 | 0.0030 interference | 0.0025 interference |
| Idler gear assembly: | | | |
| Idler gear bearing | | | |
| Bearing bore (bore for idler shaft) | 1.000 | 1.0008 | 0.0008 |
| Shaft diameter | 0.9990 | 1.0000 | 0.001 |
| Fit - shaft to bearing | 0.0000 | 0.0018 clearance | 0.0028 clearance |
| Bearing outside diameter | 1.980 | 1.981 | 0.001 |
| Bore in idler gear | 1.9785 | 1.9795 | 0.0001 |
| Fit - bearing outside diameter to idler gear | 0.0005 | 0.0025 interference | 0.002 interference |
| Bore in cylinder block for idler gear shaft | 0.998 | 0.999 | 0.001 |
| Idler shaft outside diameter | 0.9990 | 1.000 | 0.001 |
| Fit - idler shaft to bore in cylinder block | 0.0000 | 0.002 interference | 0.002 interference |
| Hydraulic pump drive assembly: | | | |
| Hydraulic pump drive bearing | | | |
| Bearing bore (bore for hydraulic pump drive shaft) | 1.0000 | 1.0008 | 0.0005 |
| Shaft diameter | 1.0008 | 1.0013 | 0.0005 |
| Fit - shaft to bearing | 0.0000 | 0.0013 | 0.0007 |
| Bearing outside diameter | 1.980 | 1.981 | 0.0005 |
| Bore in hydraulic pump drive housing for bearing | 1.979 | 1.980 | 0.0005 |
| Fit - Bearing outside diameter to hydraulic pump drive housing | 0.0000 | 0.002 interference | 0.001 interference |

Table 1-2. Repair and Replacement Standards -(Cont)

| Components | Manufacturer's dimensions and tolerances in inches | | Maximum allowable wear and clearance |
|---|---|---|---|
| | Minimum | Maximum | |
| Hydraulic pump drive assembly: | | | |
| Bore in drive gear for shaft | 1.0015 | 1.0025 | 0.0005 |
| Fit - drive gear to shaft | 0.0002 | 0.0017 interference | 0.0012 interference |
| Adapter assembly and fuel injection pump mounting: | | | |
| Bearing adapter | | | |
| Outside diameter of bearing | 1.0650 | 1.0655 | 0.0005 |
| Bore in adapter for bearing | 1.063 | 1.064 | 0.001 |
| Fit - bearing-to-bore in adapter | 0.001 | 0.0025 interference | 0.0015 inter ference |
| Bore in bearing after pressing into adapter | 0.875 | 0.877 | 0.002 |
| Shaft diameter | 0.8735 | 0.8740 | 0.0005 |
| Clearance - shaft-to-bearing | 0.001 | 0.0035 | 0.0025 |
| Lubricating oil pressure pump (crankshaft gear driven) bore in cover and body for shafts | 0.874 | 0.875 | 0.001 |
| Shaft outside diameter | 0.8715 | 0.8720 | 0.0005 |
| Clearance - shaft to bore in cover and body | 0.0020 | 0.0035 | 0.0015 |
| Bore in drive gear - for shaft | 0.8695 | 0.8705 | 0.005 |
| Fit - shaft to drive gear | 0.0010 | 0.0025 interference | 0.0015 interference |
| End clearance (gear) | 0.0025 | 0.0065 | 0.0015 |
| Outside diameter of pressure gears | 2.5694 | 2.5714 | 0.002 |
| Bore in body for pressure gears | 2.5754 | 2.5774 | 0.002 |
| Radial clearance - gears to pump body | 0.0020 | 0.004 | 0.002 |
| Drive for tachometer, overspeed and/or cranking limit switch: | | | |
| Bore for bushing in housing | 0.7495 | 0.7505 | 0.001 |
| Outside diameter of bushing | 0.752 | 0.753 | 0.001 |
| Fit of bushing in housing | 0.0015 | 0.0035 interference | 0.0025 interference |

Table 1-2. Repair and Replacement Standards - (Cont)

| Components | Manufacturer's dimensions and tolerances in inches | | Maximum allowable wear and clearance |
|---|---|---|---|
| | Minimum | Maximum | |
| Drive for tachometer, overspeed and/or cranking limit switch: | | | |
| Bore bushing installed | 0.5005 | 0.5013 | 0.001 |
| Outside diameter of shaft | 0.4990 | 0.4995 | 0.0005 |
| Clearance - shaft to bushing | 0.001 | 0.0023 | 0.002 |
| Bore in gear | 0.4975 | 0.4985 | 0.0005 |
| Fit of shaft to gear | 0.0005 | 0.002 interference | 0.0015 interference |
| End play installed | 0.000 | 0.035 | ----- |
| Electric starter commutator diameter | 1.6480 | 1.6800 | 0.002 |
| Commutator minimum turned diameter | 1.6470 | 1.6700 | |
| Brush length | 0.3750 | 0.7500 | 0.3750 |
| Armature shaft diameter | 0.8700 | 0.8720 | 0.0140 |
| Armature maximum end play | 0.0300 | 0.0500 | |
| Fit of armature shaft in bearing | 0.0020 | 0.0060 | 0.0020 |
| Armature shaft drive end diameter | 0.7450 | 0.7460 | 0.0030 |
| Distance from end of armature shaft to face of spline | 4.8100 | 4.8400 | 0.0300 |
| Clearance between thrust washer and pinion | 0.020 | 0.050 | |
| Turbocharger: | | | |
| Impeller shaft bearing bore | 0.4000 | 0.4019 | |
| Impeller shaft bearing outer diameter | 0.6182 | 0.6170 | |
| Metallic seal ring bore | | 0.5015 | |
| Impeller wheel bore to shaft fit | 0.0002 | 0.0004 | |
| Shaft radial movement | 0.003 | 0.007 | |
| Shaft end play | 0.001 | 0.0042 | |
| Bore, impeller shaft bearings | | 0.4019 | |
| Outer diameter impeller shaft bearings | 0.6182 | | |
| Thrust bearing collar bore | 0.1711 | 0.1720 | |
| Metallic seal ring bore | | 0.5015 | |

Table 1-2. Repair and Replacement Standards -(Cont)

| Components | Manufacturer's dimensions and tolerances in inches | | Maximum allowable wear and clearance |
|---|---|---|---|
| | Minimum | Maximum | |
| Turbocharger: | | | |
| Impeller to shaft fit | 0.0002 | 0.0004 | |
| Thrust bearing area width | | 0.1758 | |
| Thrust bearing ring groove | | 0.0665 | |
| Thrust collar to thrust bearing clearance - measure 3 places | 0.001 | 0.004 | |
| Journals, out of round | | 0.003 | |
| Journal diameter | 0.3992 | | |
| Sealing ring hub outer diameter | 0.682 | 0.683 | |
| Sealing ring hub-ring groove | 0.0645 | 0.0665 | |
| Clearance between thrust collar and thrust plate | 0.001 | 0.004 | |
| | Check at 3 place | | |
| Turbine wheel shaft journal diameter | 0.3992 | 0.4020 | 0.003 |
| Fuel injection pump: | | | |
| Transfer pump blades | 1.0930 | | |
| Governor linkage | | | 0.003 |
| Roller to collar setting identical within 0.003 | | | |
| Clearance between throttle shut-off shaft and linkage hook tab | 0.190 | 0.220 | |
| Fuel injection nozzle opening ("popping") pressure | 2825 psi | 2975 psi | |
| NOTE<br>New nozzles and rebuilt nozzles with new springs are set at 3100 to 3150 psi to compensate for initial set of new spindle springs. | | | |
| Oil pump assembly: | | | |
| Oil gear, driven (heat in oil 350° F ± 25° F and press on shaft) | 0.848 in. from shaft end | | |
| Oil gear, driver (heat in oil 350° F ± 25° F and press on shaft) | 1.812 in. from shaft end | | |
| Oil gear, drive (heat in oil, 350° F ± 25° F and press on shaft) | Shaft to protrude 0.057 to 0.062 in. | | |

## Table 1-3. Specified Torque Values

NOTE

Torque values listed are based on lubricated threads.

| Type | Description | Size and Thread | Grade | Torque (foot - pounds) |
|---|---|---|---|---|
| Capscrew | Bearing, cap, main | 5/8-11 x 4-1/4 | 8 | 170-190 |
| Capscrew | Connecting rod cap | (Hi-R-Thread)<br>7/16-20 x 2-5/32 | CS-8 | 80-85 |
| Capscrew | Cyl. head mtg. (short) | 9/16-12 x 5-1/16 | 8 | 130-140 |
| Capscrew | Cyl. head mtg. (long) | 9/16-12 x 8-1/8 | 8 | 130-140 |
| Capscrew | Cyl. head cover | 1/4-20 x 5/8 | 2 | 3-4 |
| Nut | Fuel inj. pump shaft retaining | 9/16-18 | 213 | 35-40 |
| Nut | Nozzle retaining | 3/4-16 | Spl. | 40-60 |
| Locknut | Nozzle adjusting screw | 7/8-14 | Spl. | 60-75 |
| Nut | Nozzle holder cap | 7/8-20 | Spl. | 60-75 |
| Nut | Nozzle fuel line | Ermetto nut | -- | 20-25 |
| Capscrew | Nozzle holder mounting | 5/16-18 x1-5/8 | 2 | 11-13 |
| Plug | Rocker arm shaft - plug | 3/4-16 | 2 | 40 |
| Nut | Turbocharger to exhaust manifold (mtg.) | 3/8-16 | Sst. | 18-21 |
| Nut | Turbocharger "V" band clamp | 1/4-28<br>(self locking) | 5 | 40-80 in. -lbs |
| Capscrew | Turbine housing to center housing | 5/16-18 x 1/2 | 2 | 100-130 in. -lbs |
| Nut | Impeller | 1/4-28 | Spl. | 18-20 in. -lbs |
| Capscrew | Center housing to backplate | 1/4-20 x 5/8<br>(phosphate coated) | 5 | 40-60 in. -lbs |
| Bolts | Generator mounting | 1-8 x 3-1/4 | 5 | 400-425 |
| Bolts | Engine mounting | 1/2-13 x 1-1/2 | 5 | 90-100 |
| Capscrew | Hydraulic pump drive gear | 1/2-20 x 2 | 8 | 95-105 |
| Stop Screw | Fuel injection pump delivery valve, retainer | 5/16-32 x 7/32 | 3 | 85-90 in. -lbs |
| Screws | Fuel injection pump headlocking (straight) | 5/16-24 x 0.8 | 2 | 300 in. lbs |
| Screws | Fuel injection pump headlocating | 7/16-20 x 1-11/32 | 2 | 175-300 in. -lbs |
| Capnut | Pwct shaft, governor arm | 8/32 | 2B | 35-40 in. -lbs |
| Nuts | Fuel solenoid, contact | 8/32 | 2 | 20-25 in-lbs |
| Capscrews | Water pump | 3/8-16 x 3-1/4<br>3/8-16 x 2 | 5<br>5 | 28-33<br>28-33 |

Table 1-3. Specified Torque Values -(Cont)

| Type | Description | Size and Thread | Grade | Torque (foot - pounds) |
|---|---|---|---|---|
| Capscrews | Water pump inlet pipe | 3/8-16 x 1 | 5 | 28-33 |
| Capscrew | Fan pulley retainer | 3/8-24 x 2 3/4 | 8 | 30-35 |
| Capscrew | Idler gear | 1/2-13 x 3 1/2 | 8 | 95-105 |
| Capscrews | Oil pan - front | 3/8-16 x 3/4 | 5 | 28-33 |
| Capscrew | Crankshaft pulley | 1-14 x 2 | 5 | 200-220 |
| Capscrews | Oil pump mounting | 1/2-13 x 1-1/2<br>1/2-13 x 3-1/2 | 5<br>5 | 68-73<br>68-73 |
| Bolt capscrew | Oil pump cover | 5/16-18 x 5/8<br>5/16-18 x 1 | 8<br>5 | 18-20<br>18-20 |
| Capscrews | Camshaft retainer | 7/16-14 x 4 | 8 | 18-20 |
| Capscrews | Flywheel housing | 1/2-13 x 1-1/4 | 5 | 73 |
| Lockbolts<br>Capscrews | Flywheel, mounting | 1/2-20 x 1/7/8 | 100 | 95-105 |
| Capscrews | Generator disc, mounting | 1/2-13 x 1-1/2 | 5 | 950-1100 in. - lbs. |

Table 1-4. Engine Generator Set Classification

| Class | Mode | Common Name | Output Frequency | Governing System | Special Component Complement | Model |
|---|---|---|---|---|---|---|
| 1 | I | Tactical Precise | 50/60 Hz | Electro-Hydraulic, with backup manual governor | Electric governor control unit, hydraulic actuator, hydraulic pump and sump, precise relay assembly, special relay assembly, tactical relay assembly | MEP105A |
| 2 | I | Tactical Utility | 50/60 Hz | Mechanical (droop type) | Tactical relay assembly, special relay assembly | MEP006A |
| 1 | II | Tactical Precise | 400 Hz | Electro-Hydraulic, with backup manual governor | Electric governor control unit, hydraulic actuator, hydraulic pump and sump, tactical relay assembly, special relay assembly | MEP115A |

Table 1-5. Electrical Performance Characteristic Parameters AC Precise (Class 1)

| Characteristic parameter | Value | Test method MIL-STD-705 |
|---|---|---|
| a. Voltage characteristics | | |
| 1. Regulation (%) | 1 | 608.1 |
| 2. Steady-state-stability (variation) (bandwidth %) | | |
| (a) Short term (30 seconds) | 1 | 608.1 |
| (b) Long term (4 hours) | 2 | 608.2 |
| 3. Transient performance | | |
| (a) Application of rated load | | |
| (1) Dip (%) | | |
| a. 60 Hz | 15 | 619.2 |
| b. 400 Hz | 12 | 619.2 |
| (2) Recovery (seconds) | 0.5 | 619.2 |
| (b) Rejection of rated load | | |
| (1) Rise (%) | | |
| a. 60 Hz | 15 | 619.2 |
| b. 400 Hz | 12 | 619.2 |
| (2) Recovery (seconds) | 0.5 | 619.2 |
| (c) Application of simulated motor load (twice rated current) | | |
| (1) Dip (%) | | |
| a. 60 Hz | 30 | 619.1 |
| b. 400 Hz | 25 | 619.1 |
| (2) Recovery to 95% of rated voltage (seconds) (Note 1) | 0.7 | 619.1 |
| 4. Waveform | | |
| (a) Maximum deviation factor (%) | 5 | 601.1 |
| (b) Maximum individual harmonic (%) | 2 | 601.4 |
| 5. Voltage unbalance with unbalanced load (%) (Note 2) | 5 | 620.2 |
| 6. Phase balance voltage (%) | 1 | 508.1 |
| 7. Voltage adjustment range | | |
| (a) 50 Hz (120/208 volts)<br>50 Hz (240/416 volts) | 190 to 213 volts<br>380 to 426 volts | 511.1 |
| (b) 60 Hz (120/208 volts)<br>60 Hz (240/416 volts) | 197 to 240 volts<br>395 to 480 volts | 511.1 |

Table 1-5. Electrical Performance Characteristic Parameters AC Precise (Class 1) (Cont)

| Character parameter | Value | Test method MIL-STD-705 |
|---|---|---|
| (c) 400 Hz (120/208 volts)<br>400 Hz (240/416 volts) | 197 to 229 volts<br>395 to 458 volts | 511.1 |
| b. Frequency characteristics | | |
| 1. Regulation (%) | 0.25 | 608.1 |
| 2. Steady-state-stability (variation) (bandwidth %) | | |
| (a) Short term (30 seconds) | 0.5 | 608.1 |
| (b) Long term (4 hours) | 1 | 608.2 |
| 3. Transient performance | | |
| (a) Application of rated load | | |
| (1) Undershoot (%) | 1.5 | 608.1 |
| (2) Recovery (seconds) | 1 | 608.1 |
| (b) Rejection of rated load | | |
| (1) Overshoot (%) | 1.5 | 608.1 |
| (2) Recovery (seconds) | 1 | 608.1 |
| 4. Frequency adjustment range (Hz) | | |
| (a) 50 Hz | ±2 | 511.2 |
| (b) 60 Hz | ±2 | 511.2 |
| (c) 400 Hz | +20<br>-10 | 511.2 |

NOTE

1. The voltage shall stabilize at or above this voltage.
2. The generator set connected for three phase output and supplying a single phase, unity power factor load connected line-to-line, with no other load on the set. The load current to be 25 percent of the rated full load current of the set.

Table 1-6. Electrical Performance Characteristic Parameters AC Utility (Class 2)

| Characteristic parameter | Value | Test method MIL-STD-705 |
|---|---|---|
| a. Voltage characteristics | | |
| 1. Regulation (%) | 3 | 608.1 |
| 2. Steady-state-stability (variation) | | |
| (a) Short term (30 seconds) | 2 | 608.1 |
| (b) Long term (4 hours) | 4 | 608.2 |
| 3. Transient performance | | |
| (a) Application of rated load | | |
| (1) Dip (%) | 20 | 619.2 |
| (2) Recovery (seconds) | 3 | 619.2 |
| (b) Rejection of rated load | | |
| (1) Rise (%) | 20 | 619.2 |
| (2) Recovery (seconds) | 3 | 619.2 |
| (c) Application of simulated motor load (twice rated current) | | |
| (1) Dip (%) | 40 | 619.1 |
| (2) Recovery to 95% of rated voltage (seconds) (Note 1) | 5 | 619.1 |
| 4. Waveform | | |
| (a) Maximum deviation factor (%) | 5 | 601.1 |
| (b) Maximum individual harmonic (%) | 2 | 601.4 |
| 5. Voltage unbalance with unbalanced load (%) (Note 2) | 5 | 620.2 |
| 6. Phase balance voltage (%) | 1 | 508.1 |
| 7. Voltage adjustment range | | |
| (a) 50 Hz (120/208 volts)<br>50 Hz (240/416 volts) | 190 to 213 volts<br>380 to 426 volts | 511.1 |
| (b) 60 Hz (120/208 volts)<br>60 Hz (240/416 volts) | 197 to 240 volts<br>395 to 480 volts | 511.1 |
| b. Frequency characteristics | | |
| 1. Regulation (%) | 3 | 608.1 |
| 2. Steady-state-stability (variation) (bandwidth %) | | |
| (a) Short term (30 seconds) | 2 | 608.1 |
| (b) Long term (4 hours) | 3 | 608.2 |
| 3. Transient performance | | |

Table 1-6. Electrical Performance Characteristic Parameters AC Utility (Class 2) (Cont)

| Characteristic parameter | Value | Test method MIL-STD-705 |
|---|---|---|
| (a) Application of rated load | | |
| (1) Undershoot (%) | 3 | 608.1 |
| (2) Recovery (seconds) | 3 | 608.1 |
| (b) Rejection of rated load | | |
| (1) Overshoot (%) | 4 | 608.1 |
| (2) Recovery (seconds) | 3 | 608.1 |
| 4. Frequency adjustment range (Hz) | | |
| (a) 50 Hz | ±2 | 511.2 |
| (b) 60 Hz | ±2 | 511.2 |

NOTE

1. The voltage shall stabilize at or above this voltage.
2. The generator set connected for three phase output and supplying a single phase, unity power load connected line-to-line with no other load on the set. The load current to be 25 percent of the rated full load current of the set.

# CHAPTER 2

## GENERAL MAINTENANCE INSTRUCTIONS

## Section I. REPAIR PARTS, SPECIAL TOOLS AND EQUIPMENT

### 2-1. Tools and Repair Parts, Equipment

There are no special tools or equipment required to perform intermediate(field) (direct and general support) and depot maintenance on generator sets Models MEP006A, MEP105A and MEP115A. A listing of recommended tools and support equipment required to perform the maintenance operations described in this manual are contained in Table 2-1.

### 2-2. Direct Support, General Support and Depot Maintenance Repair Parts.

Direct and general support and depot maintenance repair parts are contained in the technical manual listed in Appendix A of this manual.

### 2-3. Specially Designed (Fabricated) Tools and Equipment.

A breakout cable is required to troubleshoot the electric governor system of MEP-114A. The breakout cable is used to gain access to the governor Control Unit's MS3106R20-29 connector. Figure 2-0 gives fabrication instructions for the breakout cable.

## Section II. TROUBLESHOOTING

### 2-4. General.

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the engine generator set and its components. Malfunctions which may occur are listed in table 2-2. Each malfunction stated is followed by a list of probable causes of the trouble. The corrective action is described opposite the probable cause.

### 2-5. Troubleshooting Chart.

Table 2-2 lists generator set troubleshooting malfunctions, probable causes and corrective action.

### 2-6. Diagrams.

Wiring, schematic and troubleshooting diagrams for the generator set are listed in the List of Illustrations in the Table of Contents. Refer to the Operator and Organizational Maintenance Manual for diagrams not located in this manual.

## Section III. RADIO INTERFERENCE SUPPRESSION

### 2-7. General Methods Used to Attain Proper Suppression.

Essentially, suppression is attained by providing a low resistance path to ground for the stray currents. The methods used include grounding the frame with bonding straps, grounding the engine-generator set, and the use of capacitors.

### 2-8. Testing of Radio Interference Suppression Components.

Test the capacitors for leaks and shorts on a capacitor tester: replace defective capacitors. If test equipment is not available and interference is indicated, isolate the cause of interference by the trial and error method of replacing each capacitor in turn until the cause of interference is located and eliminated.

### 2-9. Interference Suppression Components.

a. Primary Suppression Components. The components, RFI capacitors, whose primary purpose is interference suppression are the three capacitors found on the generator side of CB2, main line contactor and the three on the input leads to the engine-generator sets load bank. Their description, location and removal are covered in the Operator and Organizational Maintenance Manual.

Three suggested methods of grounding the engine-generator set, instrumental in passing RFI induced currents to ground are illustrated in the Operator and Organizational Maintenance Manual.

b. Secondary Suppression Components. The components, RFI capacitors whose secondary purpose is interference suppression are the components contained within the excitation system assembly.

Testing of the RFI filter A201 is described in paragraph 8-12b (3), utilizing figure 1-8 schematic diagram, excitation system assembly. Refer to figure 8-1 for disassembly of the relay table which includes the excitation system assembly, and figure 8-15 for the excitation system assembly.

Table 2-1. TOOLS AND SUPPORT EQUIPMENT, TEST, REPAIR CALIBRATION AND HANDLING

| Item | NSN or Part No. | Reference | | Use |
|---|---|---|---|---|
| | | Fig | Para | |
| Stand, Radiator Test and Repair | 4910-00-505-4786<br>(or equivalent) | | 12-3 | Test radiator for leaks |
| Tool, Test Set, Diesel Injector | 4910-00-317-8265<br>(or equivalent) | | 14-40 | Test nozzle holder assemblies |
| Test, Stand, Diesel Injector | 4710-01-037-9417<br>(or equivalent) | 14-20<br>14-21 | 14-48 | Test fuel injection pump |
| Micrometers, Inside and Outside | 5210-00-225-9763<br>5210-00-221-1921 | | 14-30<br>14-45<br>14-54<br>14-73<br>14-78<br>14-82<br>14-86 | Measure dimension, clearance thickness, and uniformity |
| Puller Kit, Universal | 5180-00-701-8046<br>(or equivalent) | | 14-61<br>14-69<br>14-72<br>14-85 | Remove gears, flywheel and Pulleys |
| Gage, Thickness | 5210-00-222-1999<br>(or equivalent) | | 14-54<br>14-59<br>14-77<br>14-78<br>14-82<br>14-83<br>14-87 | Measure clearance |
| Grinding machine, valve face | 4910-00-540-4679<br>(or equivalent) | | 14-78 | Resurface valve face |
| Test Stand, Valve Spring | 5120-00-449-8028<br>(or equivalent) | | 14-78 | Test valve springs |
| Grinding Kit, Valve Seat | 4910-00-473-6437<br>(or equivalent) | 14-39 | 14-78 | Resurface valve seats |
| Seal Instal-lation tool | | | 14-70 | Flywheel housing seal installation |
| Allen Wrench 5/32 | 5120-00-198-5392<br>(or equivalent) | | 14-43 | Fuel injection pump, transfer pump delivery valve disassembl |
| TESTER CYLINDER COMPRESSION | 4710-00-785-6437<br>(or equivalent) | | 14-77 | Compression Test |
| Injection nozzle Holding fixture | J-6999 (33287) | | 14-39 | Disassembly of fuel injector |

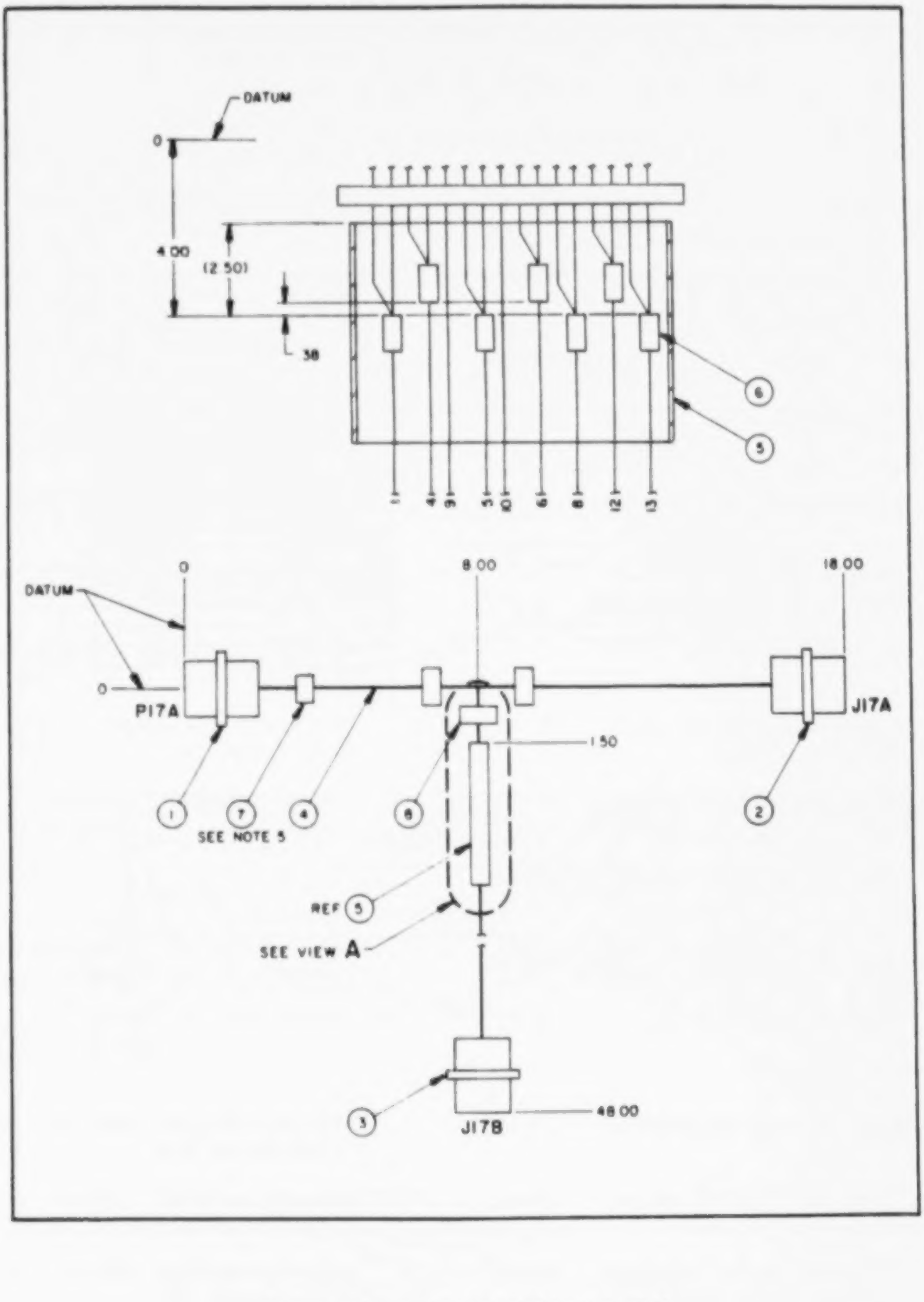

DATUM
0
4.00
(2.50)
.38
6
5
1
4
9
3
10
6
8
12
13
0
8.00
18.00
DATUM
0
P17A
J17A
1.50
1
7
SEE NOTE 5
4
8
2
REF 5
SEE VIEW A
3
J17B
48.00

Figure 2-0. Breakout Cable (Sheet 1 of 2)

NOTES:

1. ALL CONDUCTORS SHALL BE STRIPPED .50 ±.12 AND TINNED BEFORE ASSEMBLY USING SOLDER, FIND NO. 11.
2. SOLDER IN ACCORDANCE WITH MIL-STD-454, REQUIREMENT 5, USING SOLDER, FIND NO. 11.
3. TIEDOWN STRAPS, FIND NO. 8, SHALL BE LOCATED APPROXIMATELY 3.00 APART AND AT ALL BREAKOUTS.
4. CONNECTORS, FIND NO. 1, 2 AND 3 SHALL BE RUBBER STAMPED OR STENCILED WITH REFERENCE DESIGNATIONS, IN .25 HIGH, UPPER CASE GOTHIC STYLE CHARACTERS. PERMANENCY AND LEGIBILITY SHALL BE IN ACCORDANCE WITH MIL-STD-130.
5. STEEL STAMP BAND MARKER, FIND NO. 7, WITH PART NO. "30554-83-2038" IN ACCORDANCE WITH MIL-STD-130.
6. ALL UNUSED CONNECTIONS IN CONNECTORS, FIND NO. 1, 2 AND 3 SHALL BE SEALED USING PLUG, FIND NO. 10.
7. EACH WIRE SHALL BE MARKED AT 6 INCH INTERVALS WITH THE APPROPRIATE PIN LETTER IN ACCORDANCE WITH MIL-STD-130.
8. IN LIEU OF USING TERMINAL SPLICES, FIND NO. 6, WIRES MAY BE TWISTED TOGETHER AND SOLDERED AT THREE WIRE SPLICES AND COVERED WITH HEAT SHRINKABLE TUBING, FIND NO. 9.

| WIRE NO. | TERMINATION | | TERMINATION | |
|---|---|---|---|---|
| | FROM | FIND NO. | TO | FIND NO. |
| 1 | P17A-B | 1 | J17A-B | 2 |
| | P17A-B | 1 | J17B-B | 3 |
| 2 | P17A-C | 1 | J17A-C | 2 |
| 3 | P17A-D | 1 | J17A-D | 2 |
| 4 | P17A-F | 1 | J17A-F | 2 |
| | P17A-F | 1 | J17B-F | 3 |
| 5 | P17A-G | 1 | J17A-G | 2 |
| | P17A-G | 1 | J17B-G | 3 |
| 6 | P17A-H | 1 | J17A-H | 2 |
| | P17A-H | 1 | J17B-H | 3 |
| 7 | P17A-J | 1 | J17A-J | 2 |
| 8 | P17A-K | 1 | J17A-K | 2 |
| | P17A-K | 1 | J17B-K | 3 |
| 9 | P17A-L | 1 | J17B-L | 3 |
| 10 | P17A-M | 1 | J17B-M | 3 |
| 11 | P17A-R | 1 | J17A-R | 2 |
| 12 | P17A-S | 1 | J17A-S | 2 |
| | P17A-S | 1 | J17B-S | 3 |
| 13 | P17A-T | 1 | J17A-T | 2 |
| | P17A-T | 1 | J17B-T | 3 |

| FIND NO | ITEM | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|
| 11 | | | SN60WRP2 | AR | SOLDER | QQ-S-571 | |
| 10 | | | MS25251-18 | 18 | PLUG, END SEAL ELECTRIC CONNECTOR | | |
| 9 | | | M23053/7-104-9 | AR | INSULATION SLEEVING ELEC HEAT-SHRINKABLE .125 ID | MIL-I-23053/7 | |
| 8 | | | MS3367-5-9 | AR | STRAP, TIEDOWN ELECTRICAL | | |
| 7 | | | M43436/1-3 | 1 | BAND MARKER, CRIMP STYLE | MIL-B-43436/1 | |
| 6 | | | M7928/5-4 | 7 | TERMINAL, SPLICE | MIL-T-7928/5 | |
| 5 | | | M23053/7-108-0 | 1 | INSULATION SLEEVING ELEC HEAT-SHRINKABLE 6.00 L .75 ID | MIL-I-23053/7 | |
| 4 | | | M5086/2-16-9 | AR | WIRE, ELECTRICAL, 16 AWG, COLOR WHT | MIL-W-5086/2 | |
| 3 | | | MS3101R20-29S | 1 | CONNECTOR, ELECTRICAL | | |
| 2 | | | MS3101R20-29P | 1 | CONNECTOR, ELECTRICAL | | |
| 1 | | | MS3106R20-29S | 1 | CONNECTOR ELECTRICAL | | |

Figure 2-0. Breakout Cable (Sheet 2 of 2)

Table 2-1. TOLLS AND SUPPORT EQUIPMENT, TEST, REPAIR CALIBRATION AND HANDLING

| Item | NSN or Part No | Reference | | Use |
|---|---|---|---|---|
| | | Fig | Para | |
| Pin Vise | J-4298-1 (33287) (or equivalent) | | 14-39 | Disassembly and cleaning fuel injectors |
| Nozzle cleaning Wire | J-8537-3 (33287) (or equivalent) | | 14-39 | Cleaning injector valve body orifices |
| Injection Nozzle bore cleaner | J-21609-7 (33287) (or equivalent) | | 14-39 | Cleaning nozzle bore with cleaning solution |
| Snap ring pliers | 13337 (84760) (or equivalent) | | 14-43 | Fuel injection pump governor disassembly |
| Water pump coolant seal installer | 5120-00-197-4920 (or equivalent) | | 14-59 | Water pump coolant seal installation |
| Seal Installer Handle | 5120-00-677-2259 (or equivalent) | | 14-59 | Water pump coolant seal installation |
| Soft Faced Hammer | 5120-00-900-7882 (or equivalent) | 14-34 | 14-72<br>14-87 | Timing gear cover removal<br>Crankshaft end play test |
| Spring Compression Tool | 5120-00-239-8686 (or equivalent) | 14-38 | 14-77 | Valve spring retainer removal |
| Valve Seat Installation Tool | 5120-00-473-7393 (or equivalent) | | 14-78 | Exhaust valve seat installation |
| Valve spring Testing Tool | 5120-00-449-8028 (or equivalent) | | 14-78 | Intake and exhaust valve spring test |
| Cold box | | | 14-78 | Exhaust valve seat insert installation |
| Connecting rod checking fixture | 4910-00-733-2487 (or equivalent) | | 14-82 | Connecting rod length and twist test |
| Piston pin installation and removal tool | | | 14-83 | Piston pin installation |
| Plastic head hammer | 5120-00-900-7882 (or equivalent) | | 14-83 | Connecting rod cap installation |
| Cylinder honing tool | 5130-00-473-6236 (or equivalent) | | 14-85 | Honing cylinder sleeves |
| Depth Micrometer | 5120-00-619-4045 (or equivalent) | | 14-86 | Cylinder sleeve protrusion (standout) measurement. |

TABLE 2-1. TOOLS AND SUPPORT EQUIPMENT, TEST, REPAIR CALIBRATION AND HANDLING (CONT)

| Item | NSN or Part No | REFERENCE | | Use |
|---|---|---|---|---|
| | | Fig | Para | |
| Cylinder sleeve installation tool | | | 14-87 | Cylinder slèeve installation |
| Brass wire brush | 16488 (84760) (or equivalent) | | 14-39 | Cleaning fuel injector nozzle valve body |
| Holding fixture | 5120-00-816-7030 (or equivalent) | 14-21 | 14-45 | Facilitates assembly of leaf springs in hydraulic head and rotor assembly. |
| Kit centrality gage | 16182 (84760) (or equivalent) | 14-21 | 14-45 | Enables adjustment of rollers in hydraulic head and rotor assembly. |
| Delivery valve extractor | 13383 (84760) (or equivalent) | 14-21 | 14-45 | Enables installation of delivery valve in fuel injector pump |
| Piston ring installation tool | 16199 (84760) (or equivalent) | 14-21 | 14-45 | Enables adjustment of power piston |
| Linkage gage | 13389 (84760) (or equivalent) | 14-21 | 14-45 | Enables adjustment of throttle linkage on fuel injector pump. |
| Drive shaft seal assembly tool | 13369 (84760) (or equivalent) | 14-21 | 14-49 | Enables installing drive shaft in fuel injector pump |
| Multimeter | 6625-00-553-0142 (or equivalent) | | 3-3 | Check resistance |
| | | | 3-10 | Control box relay testing |
| | | | 3-10 & | Control box relay assembly |
| | | | 6-4 | Testing |
| | | | 6-9 | Current transformer testing |
| | | | 7-2 | Electro-hydraulic governing system malfunction |
| | | | 7-6 | Electro-hydraulic governing system resistance test |
| | | 8-14 | 8-7 | Permissive parallel relay test |
| | | 1-8 | 8-12 | Excitation system assembly test |
| | | | 9-2, 9-3 | Generator, removal disassembly and test |
| | | 14-2 | 14-10 | Battery charging alternator |
| | | 14-3 | 14-12 | inspection and test |
| | | 14-6 | 14-19 | Speed switch test |
| Test Set, Generator and voltage regulator automotive | 4910-00-092-9136 (or equivalent) | 14-1 | 14-9 | Battery charging alternator |

TABLE 2-1. TOOLS AND SUPPORT EQUIPMENT, TEST, REPAIR CALIBRATION AND HANDLING (CONT)

| | | REFERENCE | | |
|---|---|---|---|---|
| Item | NSN or Part No | Fig | Para | Use |
| AC Power Supply 120/208 Vac, 3 Phase, 4 wire 60 Hz | 17 BU-3 Superior Electric (58474) (or equivalent) | 3-4<br>8-11 | 3-7<br>8-7 | Thermal watt converter testing<br>Overload relay test |
| AC Voltmeter 0-120 VAC | Model 904 Weston (65092) (or equivalent) | 8-8<br>8-19<br>8-21 | 8-7<br>8-12<br>8-18 | Short circuit relay test<br>Excitation system assembly test<br>Load measuring unit test |
| Test stand Actuator | 4940-00-152-2107 (or equivalent) | 13-3 | 13-6 | Hydraulic actuator test |
| AC Ammeter | Model 433 Weston (65092) or equivalent) | 8-11 | 8-7 | Overload relay test |
| Test Set, Gen & Voltage Regulator | 4910-00-092-9136 (or equivalent) | 14-2 | 14-10 | Battery charging alternator inspection and test |
| Test Set, armature | 6625-00-828-5810 (or equivalent) | 14-11 | 14-28 | Electric starter inspection and test |
| Variable voltage | Model 1308 | 8-8 | 8-7 | Short circuit (Bench Test) relay test (400HZ) |
| Variable frequency power supply (0-160) VAC, 20-450 Hz | General Radio (24655) (or equivalent) | 8-9 | 8-7 | Overvoltage relay test |
| | | 8-12 | 8-7 | Underfrequency relay test (50/60 Hz) |
| | | 8-12 | 8-7 | Underfrequency relay test (400HZ) |
| | | 8-13 | 8-7 | Undervoltage relay test (400 HZ) |
| | | 8-14 | 8-7 | Permissive parallel relay test |
| | | 7-3 | 7-6 | Electro-hydraulic governor Magnetic amplifier bias test 50/60 HZ |
| | | 7-4 | 7-6 | Electro-hydraulic governor frequency sensing test (50/60 Hz) |
| | | 7-5 | 7-6 | Electro-hydraulic governor rectifier bridge and feedback winding test (50/60 Hz) |
| | | 7-6 | 7-6 | Electro-hydraulic governor parallel winding test (50/60 Hz) |
| | | 7-7 | 7-6 | Electro-hydraulic governor magnetic amplifier bias test (400 Hz) |
| | | 7-8 | 7-6 | Electro-hydraulic governor frequency sensing test (400 Hz) |
| | | 7-9 | 7-6 | Electro-hydraulic governor rectifier bridge and feedback winding test (400 Hz) |
| | | 7-10 | 7-6 | Electro-hydraulic governor parallel winding test (400 Hz) |

TABLE 2-1. TOOLS AND SUPPORT EQUIPMENT, TEST, REPAIR CALIBRATION AND HANDLING (CONT)

| Item | NSN or Part No | REFERENCE |  | Use |
|---|---|---|---|---|
|  |  | Fig | Para |  |
|  |  |  | 3-10 | Control box relay assembly testing |
|  |  |  | 3-9 | Frequency meter and transducer test |
|  |  |  | 6-9 | Current transformer testing |
| DC Power Supply (24 vdc) | Model MP40 (98853) (or equivalent) | 8-8 | 8-7 | Short circuit relay test (bench test) |
|  |  | 8-9 | 8-7 | Overvoltage relay test |
|  |  | 8-10 | 8-7 | Reverse power relay test |
|  |  | 8-11 | 8-7 | Overload relay test |
|  |  | 8-12 | 8-7 | Underfrequency relay test |
|  |  | 8-13 | 8-7 | Undervoltage relay test |
|  |  | 7-6 | 7-6 | Electric governor control unit parallel winding test |
|  |  | 8-14 | 8-7 | Permissive parallel relay |
|  |  |  | 8-7 | DC relay assembly test |
|  |  | 13-13 | 13-6 | Hydraulic actuator test |
| DC power supply 27 ± .5 Vdc | Model MP4-0 (98853)(or equivalent) | 7-3 | 7-6 | Electro-hydraulic governor magnetic amplifier bias test (50/60 Hz) (Bench Test) |
|  |  | 7-4 | 7-6 | Electro-hydraulic governor frequency sensing test (50/60 Hz) |
|  |  | 7-5 | 7-6 | Electro-hydraulic governor rectifier bridge and feedback winding test (50/60 Hz) |
|  |  | 7-6 | 7-6 | Electro-hydraulic governor parallel winding test (50/60 Hz) |
|  |  | 7-7 | 7-6 | Electro-hydraulic governor magnetic amplifier test (400Hz) |
|  |  | 7-8 | 7-6 | Electro-hydraulic governor frequency sensing test (400 Hz) |
|  |  | 7-9 | 7-6 | Electric-hydraulic governor receptacle bridge and feedback winding test (400 Hz) |
|  |  | 7-10 | 7-6 | Electro-hydraulic parallel winding test (400 Hz) |
| DC Power Supply variable voltage(0-5 Vdc) | Model MP40 (98853) (Or equivalent) | 8-10 | 8-7 | Reverse power relay test (bench test) |
| AC Power Supply variable voltage 0-10 VAC) | Model 116B Superior Electric (variac) (58474) (or equivalent) | 8-10 | 8-7 | Reverse power relay test (bench test) |
| Miliammeter dc, 0-1000 ma | 6625-00-883-9734 (or equivalent) | 7-3 | 7-6 | Electro-hydraulic governor magnetic amplifier bias test (50/60 Hz) |

TABLE 2-1. TOOLS AND SUPPORT EQUIPMENT, TEST, REPAIR CALIBRATION AND HANDLING (CONT)

| Item | NSN or Part No. | REFERENCE Fig | REFERENCE Para | Use |
|---|---|---|---|---|
| | | 7-4 | 7-6 | Electro-hydraulic governor frequency sensing test (50/60Hz) |
| | | 7-5 | 7-6 | Electro-hydraulic governor rectifier bridge and feedback winding test (50/60 Hz) |
| | | 7-6 | 7-6 | Electro-hydraulic governor parallel winding test (50/60 Hz) |
| | | 7-7 | 7-6 | Electro-hydraulic governor magnetic amplifier bias test (400 Hz) |
| | | 7-8 | 7-6 | Electro-hydraulic governor frequency sensing test (400 Hz) |
| | | 7-9 | 7-6 | Electro-hydraulic governor rectifier bridge and feedback winding test (400 Hz) |
| | | 7-10 | 7-6 | Electro-hydraulic governor parallel winding test (400 Hz) |
| | | 13-3 | 13-6 | Hydraulic actuator test |
| Voltmeter 0-5 Vdc | Model Weston (65092 (or equivalent) | 8-10 | 8-7 | Reverse power relay test (bench test) |
| Frequency meter set | 6625-00-893-0021 (or equivalent) | 8-12 | 8-7 | Underfrequency relay test (400 Hz) |
| | | | 3-9 | Control box relay assembly testing(frequency meter and transducer test) |
| | | 8-12 | 8-7 | Underfrequency relay test (50/60 Hz) |
| AC Wattmeter Three Phase | Model 329 (65092) | | 3-6 | AC Wattmeter testing |
| Voltmeter 0-10 Vac | Model 904 (65092) | 8-21 | 8-18 | Load measuring unit test (bench Test) |

TABLE 2-1. TOOLS AND SUPPORT EQUIPMENT, TEST, REPAIR CALIBRATION AND HANDLING (CONT)

| ITEM | NSN or PART NO | REFERENCE |  | USE |
|---|---|---|---|---|
|  |  | Fig | Para |  |
| Voltmeter 0-50 Vdc | Model 901 (65092) | 8-21 | 8-18 | Load measuring unit test (Bench test) |
| Autotransformer | 6625-00-124-7254 (or equivalent) | 7-5 | 7-6 | Electro-hydraulic governor rectifier bridge and feedback winding test (50/60 Hz) |
|  |  | 7-9 | 7-6 | Electro-hydraulic governor rectifier bridge and feedback winding test (400 Hz) |
| Miliammeter dc, zero center -10, 0, +10 ma | 6625-00-883-9734 | 7-5 | 7-6 | Electro-hydraulic governor rectifier bridge and feedback winding test (50/60 Hz) |
|  |  | 7-9 | 7-6 | Electro-hydraulic governor rectifier bridge and feedback winding test (400 Hz) |
| Solder gun | 3439-00-517-0603 (or equivalent) | 9-2 | 9-2 | Generator removal, disassembly and test |
| Test Gage and Hose Ay | 4910-00-774-9343 (or equivalent) | 13-3 | 13-2 | Hydraulic speed control actuator |
|  |  |  | 14-14 | Hydraulic pump assembly (class 1 precise sets) |
|  |  | 14-5 | 14-16 | Hydraulic pump reassembly, installation and adjustment |
| Test Stand, Actuator | 4940-00-152-2107 (or equivalent) | 13-3 | 13-6 | Hydraulic actuator test (bench test) |
| Test Stand, Magnetic | 4910-00-912-3690 (or equivalent) |  | 14-19 | Testing speed switch (bench test) |
| Voltmeter 0-300 Vac | Model 904 (65092) | 8-21 | 8-18 | Load measuring unit test (bench test) |
| Power supply 208 Vac, 3 phase 47-430 Hz |  | 8-21 | 8-18 | Load measuring unit test (Bench test) |
| Wheatstone bridge | 6625-00-927-4451 (or equivalent) |  | 9-2 | Generator, removal, disassembly and test |
| Megger 500 Vdc | 6625-00-581-2466 (or equivalent) | 14-12 | 14-29 | Electric sater motor repair |
|  |  | 14-12 | 14-28 | Electric starter inspection and test |
|  |  | 14-2 | 14-10 | Battery charging alternator inspection and test |

TABLE 2-1. TOOLS AND SUPPORT EQUIPMENT, TEST, REPAIR CALIBRATION AND HANDLING (CONT)

| Item | NSN or Part No. | REFERENCE |  | Use |
|---|---|---|---|---|
|  |  | Fig | Para |  |
|  |  |  | 9-2 | Generator, removal, disassembly and test |
| Double Kelvin Bridge |  |  | 9-2 | Generator, removal, disassembly and test |
| Engine support Stand | 4910-00-808-3372 (or equivalent) |  | 14-3 | Support engine after removal from skid base |
| Engine Stand Adapter plate | J22289-1 (33287) (or equivalent) |  | 14-3 | Support engine after removal from skid base |
| Engine stand adapter plate spacers<br>En | J22289-2 (33287) (or equivalent) |  | 14-3 | Support engine after removal from skid base |
| Engine jacking stud support angle | 70-1419 (93742) (or equivalent) | 2-1 | 2-11 | Support engine on skid base when removing generator |
| Engine jacking stud support angle bolts | 5/8-11x 1-1/2 cap screw (or equivalent) | 2-1 | 2-11 | Support engine on skid base when removing generator |
| Engine Jacking stud | 70-1420 (93742) (or equivalent) | 2-1 | 2-11 | Support engine on skid base when removing generator |
| Generator lifting eye bolt | 70-1930(12532) | 2-1 | 2-11 | Provide generator lifting point |
| Hoist chain, 3 ton capacity | 3950-00-292-9879 (or equivalent) | 2-1 | 2-11 | Lift generator or engine from skid base |
| Dial indicator 0-.1.00 | 5210-00-277-8840 (or equivalent) | 14-21 | 14-45 | Fuel injection pump reassembly |
| Wrench, socket | 5120-00-596-1199 (or equivalent) |  | 14-83 | Installation of connecting rod cap screws |
| Wrench, box cylinder short head | 5120-00-930-6346 (or equivalent) | 14-42 | 14-79 | Torquing cylinder head bolts |
| Dial Indicator adaptor | J-21886 (33287) Kent-Moore (or equivalent |  | 14-52 | Turbocharger end play radial |
| Bearing retainer installation tool | JD-274 (00713) (or equivalent) |  | 14-55 | Turbocharger assembly |
| Magnifying glass | 6650-00-252-6271 (or equivalent |  | 14-39 | Nozzle assembly valve |
| Voltage-freqnency Recorder | 6625-00-498-9984 (or equivalent | 16-1 | 16-22 | To evaluate set performance |

Table 2-2. Generator Set Troubleshooting

| Malfunction | Probable cause | Corrective action |
|---|---|---|
| 1. Engine fails to crank when START-STOP-RUN switch is moved to START position | a. Defective crank relay (K3). | a. With START-STOP-RUN switch (S2) in START position, check for 24 Vdc across relay K3 (two small terminals) X1 and X2 in set special box. If voltage is present, check for voltage across relay contacts, two large terminals. If voltage is present, relay K3 is defective. Replace relay K3 (para 8-7). |
| | b. Defective CR3 diode. | b. Gain access to set special relay assembly (para 8-6). Test diode CR3 (para 14-10). Replace defective diode. |
| | c. Defective ring gear. | c. Inspect ring gear. Replace defective ring gear (para 14-69 and 14-70). |
| | d. Starter motor brushes worn or not contacting properly. | d. Replace starter motor brushes (para 14-26, and fig. 14-10). |
| | e. Defective starter motor solenoid. | e. Replace starter motor solenoid (para 14-27 and fig. 14-10) and adjust (para 14-30 and fig. 14-14). |
| | f. Defective starter motor. | f. Replace starter motor (para. 14-25, and fig. 14-9). |
| 2. Engine cranks but fails to start | a. Incorrect valve and injector timing. | a. Time as shown in figure 14-34. |
| | b. Valves burned or sticking. | b. Check valves (para 14-77). Replace valves (para 14-77 and 14-79). |
| | c. Valve clearance incorrect. | c. Check clearance. Adjust fuel injector (Operator and Organizational Maintenance Manual). |
| | d. Governor actuator improperly positioned. | d. Check governor (para 7-2). Adjust governor actuator (para 7-8). |
| | e. Defective solenoid on fuel injection pump. | e. Replace defective solenoid (para 14-46).<br>NOTE<br>Gain access to set special relay assembly. |
| | f. Dc relay control assembly (A5) defective. | f. With S2 in START position, measure dc voltage between A5 terminal 21 and ground stud. It should read 24 Vdc. Measure dc voltage between A5 terminal 23 and ground stud. If no voltage exists, replace dc relay control circuit assembly (A5) (para 8-6). |

Table 2-2. Generator Set Troubleshooting (Cont)

| Malfunction | Probable cause | Corrective action |
|---|---|---|
| 3. Engine runs when START-STOP-RUN switch is held in START position, but stops when switch is put in RUN | a. Defective stop-run relay (K1). | a. Replace defective relay K1 in generator control assembly (fig 3-3 and 3-5). |
| | b. Defective overvoltage relay (K2). | b. Test overvoltage relay. Replace defective relay (para 8-6). |
| | c. Defective fuel level relay | c. Replace defective relay K8 in the special relay assembly (para 8-6). |
| 4. Engine runs rough | a. Incorrect timing. | a. Time engine as illustrated in figure 14-25. |
| | b. Defective fuel injection pump. | b. Check fuel injection pump (para. 14-44). Repair or replace fuel injection pump (para 14-44 and 14-45). |
| | c. Nozzle injector assembly malfunction. | c. Repair or replace nozzle injector assemblies (para 14-38 thru 14-41). |
| | d. Sticking valves. | d. Check valves and springs (para. 14-77). Repair or replace valves (para 14-77 thru 14-78). |
| | e. Blown cylinder head gasket. | e. Replace cylinder head gasket (para 14-79.) |
| | f. Defective cylinder sleeve. | f. Replace cylinder sleeve (para 14-85 thru 14-87). |
| | g. Defective piston. | g. Replace piston assembly (para 14-81 thru 14-83). |
| | h. Broken or bent push rod. | h. Inspect valve operating mechanism. Replace defective push rod (para 14-77). |
| 5. Engine runs erratically or misfires | a. Improper fuel timing. | a. Time fuel injection pump (para 14-49). |
| | b. Improper governor adjustment. | b. Adjust governor (para 7-8). |
| | c. Defective fuel injection pump. | c. Inspect fuel injection pump, Replace or repair (para 14-43, 14-44 and 14-45). |
| | d. Deleted | |
| | e. Worn camshaft bearings. | e. Replace camshaft bearing (para 14-85 and 14-87). |
| 6. Engine runs but fails to reach rated speed | a. Improper governor adjustment. | a. Adjust governor (para 7-8). |

Table 2-2. Generator Set Troubleshooting (Cont)

| | Malfunction | Probable cause | Corrective action |
|---|---|---|---|
| 6. | Engine runs but fails to reach rated speed. (Continued) | b. Lack of fuel. | **b. Check fuel level. Replenish if necessary. (Operator and organizational maintenance manual).** |
| | | c. Defective fuel injection pump. | **c. Inspect fuel injection pump. Repair or replace as required (para 14-44 amd 14-45).** |
| 7. | Low oil pressure | a. Defective oil pump. | **a. Replace oil pump (para 14-65 thru 14-67).** |
| | | b. Worn main bearing. | **b. Replace main bearings (para 14-85 thru 14-87).** |
| | | c. Defective oil regulating valve (oil pressure below 45 psi). | **c. Replace defective valve in cylinder block (para 14-78 and 14-87).** |
| 8. | High oil pressure | Defective oil regulating valve. (oil pressure above 45 psi) | **Replace defective valve in cylinder block (para 14-78 and 14-87).** |
| 9. | Engine lubricating oil consumption high | a. Pistons, sleeves or rings worn or defective. | **a. Replace pistons and rings (para. 14-81 thru 14-83). Replace cylinder sleeve (para 14-85 thru 14-87).** |
| | | b. Main bearings worn. | **b. Replace main bearings (para 14-85 thru 14-87).** |
| | | c. Oil leaks at crankshaft seals | **c. Replace seal (para 14-85 thru 14-87).** |
| 10. | Engine noisy | a. Main bearings worn. | **a. Replace if required (para 14-85 thru 14-87).** |
| | | b. Connecting rod bearings worn. | **b. Replace if required (para 14-81 thru 14-83).** |
| | | c. Piston pins loose. | **c. Replace the piston or rings (para 14-81 thru 14-83).** |
| | | d. Piston or rings broken. | **d. Replace pistons or rings (para 14-81 thru 14-83).** |
| | | e. Timing gears worn. | **e. Inspect gear fit and replace gears if required (para 14-72 thru 14-74).** |
| | | f. Crankshaft journals eccentric or out of round. | **f. Inspect crankshaft and repair or replace (para 14-85 thru 14-87).** |
| | | g. Connecting rods misalined. | **g. Realine connecting rods (para 14-82).** |
| | | h. Incorrect valve adjustment. | **h. Check valve adjustment. Adjust valves (Operator and Organizational Maintenance Manual).** |

Table 2-2. Generator Set Troubleshooting (Cont)

| Malfunction | Probable cause | Corrective action |
|---|---|---|
| 10. Engine noisy (Continued) | i. Flywheel loose. | i. Inspect flywheel attaching bolts and tighten if required (para 14-69 and 14-70). |
| 11. Engine overheats | a. Deleted | |
| | b. Water pump defective. | b. Repair or replace water pump (para 14-57 thru 14-59). |
| | c. Radiator leaks or is clogged. | c. Repair or replace radiator (para 12-2 thru 12-4). |
| | d. Defective shutter or shutter linkage. | d. Repair or replace shutter and shutter linkage (para 12-2 thru 12-4). |
| 12. Engine lacks power | a. Defective actuator. | a. Isolate trouble (para 13-2). Repair or replace actuator (para 13-3). |
| | b. Valves burned or sticking. | b. Isolate trouble (para 14-77). Replace valves (para 14-77 thru 14-79). |
| | c. Piston rings worn or defective. | c. Replace piston rings (para 14-81 thru 14-83). |
| | d. Defective nozzle injector assembly. | d. Repair or replace nozzle injector assembly (para 14-38 thru 14-41). |
| | e. Defective fuel injection pump. | e. Isolate trouble (para 14-43). Repair or replace and test fuel injection pump. (para 14-43 thru 14-45 and 14-48). |
| | f. Improper engine timing. | f. Time engine as shown in figure 14.25. |
| 13. Excessive generator set vibration | a. Defective valves. | a. Isolate trouble (para 14-77). Replace valves (para 14-77 thru 14-79). |
| | b. Fuel injector pump assembly malfunction. | b. Isolate trouble (para 14-43). Clean, repair or replace injectors (fig. 14-21). |
| | c. Loose flywheel or flywheel housing mounting. | c. Tighten flywheel bolts or housing bolts (para 14-69). |
| | d. Loose vibration dampener. | d. Inspect vibration dampener. Tighten vibration dampener (para 14-60, 14-61 and 14-63). |
| 14. Noisy turbocharger | a. Worn turbocharger bearings. | a. Inspect turbocharger. Repair or rebuild turbocharger (para 14-52 thru 14-55). |

Table 2-2. Generator Set Troubleshooting (Cont)

| Malfunction | Probable cause | Corrective action |
|---|---|---|
| 14. Noisy turbocharger (Continued) | b. Excessive turbocharger impeller end play. | b. Measure end play (para 14-52). Disassemble and add correct number of shims (para 14-52 and 14-55). |
| 15. Turbocharger leaks oil | a. Worn or broken turbocharger shaft seal ring. | a. Inspect turbocharger. Replace shaft seal ring (para. 14-53, thru 14-55). |
| | b. Worn or broken turbocharger oil pressure and drain seal rings. | b. Inspect turbocharger. Replace turbocharger oil pressure and drain seal rings (para 14-53 thru 14-55). |
| 16. Excessive gear noise around front of engine | a. Defective vibration dampener. | a. Inspect vibration dampener. Replace vibration dampener (para 14-60, 14-61 and 14-63). |
| | b. Excessive timing gear backlash. | b. Inspect timing gears (para 14-73). Replace timing gears (para 14-72 and 14-75). |
| 17. Low engine compression | a. Defective piston rings. | a. Replace piston rings (para 14-81 thru 14-83). |
| | b. Defective pistons and cylinder sleeves. | b. Replace pistons (para 14-81 and 14-83) and cylinder sleeves (para 14-85 thru 14-87). |
| | c. Leaking or defective valves. | c. Isolate trouble (para 14-77). Replace valves (para 14-77 thru 14-79). |
| 18. Main generator output voltage too low | a. Exciter-regulator defective. | a. Check exciter regulator (para 8-3). Replace exciter voltage regulator (para 8-10 thru 8-14). |
| | b. Rotor assembly defective. | b. Check rotor resistance. Check for shorts or grounds. Replace, repair or rebuild if required (para 9-2, 9-3, 9-4, 9-6 and 9-7). |
| | c. Stator defective. | c. Check stator resistance. Check for grounds or shorts. Replace, repair or rebuild if required (para 9-2, 9-3, 9-4, 9-6 and 9-7). |
| | d. Exciter rotor defective. | d. Check exciter resistance. Check for shorts or grounds (para 9-2). Replace exciter if defective. (para 9-5, 9-6 and 9-7). |
| | e. Exciter stator defective. | e. Check exciter stator resistance. Check for shorts or grounds (para 9-2). Replace exciter stator (para 9-5, 9-6 and 9-7). |

Table 2-2. Generator Set Troubleshooting (Cont)

| Malfunction | Probable cause | Corrective action |
|---|---|---|
| 18. Main generator output voltage too low. | f. Rotating diodes defective. | f. Check diodes (para 9-3). Replace diodes as required. (Operator and Organizational Maintenance Manual). |
| 19. Main generator output too high. | Exciter-regulator defective. | Check exciter regulator (para 8-3). Replace exciter voltage regulator (para 8-10 thru 8-14). |
| 20. Main generator noisy. | a. Defective bearing. | a. Replace bearing (para 9-2 and 9-6). |
| | b. Generator fan loose or defective. | b. Inspect generator fan. Tighten, repair or replace fan (para 9-2, 9-3 and 9-6). |
| 21. Main generator frequency fluctuates or drifts. | a. Governor system defective. | a. Adjust governor system (para 7-2). Repair or replace as required (para 7-3 thru 7-6). |
| | b. Engine malfunctioning. | b. See items 4, 5, and 6. |
| 22. Main generator fails to flash. | a. Field flash circuit defective. | a. Check field flash relay (K5) (fig. 1-11). Disconnect battery negative . Disconnect J9 on regulator. Apply 24 Vdc to terminals 13(+) and 15(-) on A5 assembly. Check continuity between terminals 1-14 and 2-15. If circuit is open, replace K5 relay on A5. Check R219 and CR207 in exciter regulator (para 8-3). Replace defective components as required (para 8-10 thru 8-14). |
| | b. Defective exciter rotor. | b. Check resistance of exciter rotor. Check for short or ground. Replace as required. (para 9-2, 9-3, 9-5, 9-6 and 9-7). |
| | c. Defective exciter stator. | c. Check resistance of exciter stator. Check for short or ground (para 9-2). Replace as required. (para 9-2, 9-3, 9-5, 9-6 and 9-7). |
| | d. Defective rotating diodes. | d. Check rotating diodes (para 9-3). Replace any defective diode (para 9-2 and 9-6). |
| | e. Defective generator stator. | e. Check generator - stator resistance. Check for short or ground (para 9-2). Repair or rebuild as required. (para 9-3, 9-4, 9-6 and 9-7). |
| | f. Defective speed switch. | f. Check S9-1, normally open, for proper operation (para 14-19). |
| | g. Defective excitation assembly. | g. Check R225 and R226 (para 8-12). |

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Table 2-2. Generator Set Troubleshooting (Cont)

| Malfunction | Probable cause | Corrective action |
|---|---|---|
| 23. Frequency meter fails to register. | a. Frequency meter defective. | a. Replace meter and transducer (Refer to Operator and Organizational Maintenance Manual). |
| | b. Frequency transducer defective. | b. Replace frequency meter and transducer (Refer to Operator and Organizational Maintenance Manual). |
| | c. Engine speed too low. | c. Raise engine speed to rated value. (Refer to Operator and Organizational Maintenance Manual). |
| 24. Percent power meter fails to register. | a. Percent power meter defective. | a. Replace meter (Refer to Operator and Organizational Maintenance Manual). |
| | b. Thermal watt converter defective. | b. Replace thermal watt converter A1 (para 3-7). |
| | c. Set operating at no-load. | c. Adjust load bank or apply load. (Refer to Operator and Organizational Maintenance Manual). |
| 25. Units paralleling out of phase (B2) (contactor closing when paralleling lights are bright). | Permissive paralleling relay (K16) defective. | Measure ac voltage between 1 and 2 on K16. When lights are the brightest, 120 volts should exist; voltage should decrease toward zero, as lights dim. If voltage is OK, remove leads from relay pins 7 and 8. Measure continuity across pins 7 and 8 while observing voltmeter connected at pins 1 and 2. Continuity should exist at 9 volts and below. There should be no continuity at 9 volts and above. Replace defective relay K16 (para 8-6 and 8-7). |
| 26. Remote sensing inoperative. | a. Local - Remote voltage switch (S5) on control panel in local position or defective. | a. Place switch in correct position. Check switch for continuity in all positions. (Refer to Operator and Organizational Maintenance Manual). |
| | b. Remote sensing leads not connected to sensing point. | b. Check connections. Make correct connections. |
| | c. K6 relay defective. | c. Check relay K6. Replace if defective (para 3-5 and 3-10). |
| | d. Control panel relay (A4) components (R10 and CR1) defective. | d. Replace R10 or CR1 if defective (para 3-3 thru 3-5). |

Table 2-2. Generator Set Troubleshooting (Cont)

| Malfunction | Probable cause | Corrective action |
|---|---|---|
| 27. Generator runs at 130 percent or more rated current for longer than 10 minutes, CB2 does not open and overload indicator does not light. | a. Defective overload relay (K14). | a. Replace K14 (para 8-6 and 8-7). |
| | b. Defective resistors R23, R24 or R25. | b. Replace resistor R23, R24 or R25, if ohmmeter test indicates defect (fig. 8-2 and 8-3). |
| | c. Defective current transformer CT1, CT2 or CT3. | c. Replace defective current transformer CT1, CT2 or CT3 (para 6-7 thru 6-8). |
| 28. Generator runs at overvoltage (130 percent. Set does not shut down and overvoltage indicator does not light. | Defective overvoltage relay K2. | Replace overvoltage relay (para 8-6 and 8-7). |
| 29. Generator runs undervoltage (85 percent of rated voltage or less). CB2 does not open and undervoltage indicator does not light (Class I only) | Defective undervoltage relay K11. | Replace undervoltage relay K11 (para 8-6 and 8-7). |
| 30. Percent power meter reads down scale with 2 or more sets paralleled. | Reverse power relay (K15) defective. | Measure dc voltage at K15 terminals 3 and 4. It should be 24 volts (positive on terminal 3). Check for Vdc at pins 1 and 2. If 2 or more Vdc are present with 1 positive replace reverse power relay (para 8-6 and 8-7). |
| 31. Set starts but will not run unless protection bypass switch (S7) is closed. | a. System fault as indicated by fault indicator panel. | a. Correct indicated fault. |
| | b. If no lamp is illuminated, press fault indicator test switch to ensure that all lamps are working. | b. Replace any defective lamps. |
| | NOTE<br>If the corrective action in a and b above does not correct the malfunction, proceed to determine if one of the following components are defective by placing jumpers across their contacts as follows: | |
| | c. Overvoltage relay K2. | c. Terminals 3 and 4 of K2. |
| | d. Low oil pressure switch OP and high coolant temperature switch WT. | d. Terminal 3 of K2 and 4 of A5. |

Table 2-2. Generator Set Troubleshooting (Cont)

| Malfunction | Probable cause | Corrective action |
|---|---|---|
| | e. Fuel level relay K8. | e. Terminals 4 and 16 of A5. |
| | NOTE<br>Start the generator set and open the protection bypass switch S7. Remove the jumpers installed in c, d, and e above. If the set stops when one of the jumpers is removed, that component is defective and must be replaced. If the set shuts down when the jumper in step d is removed test OP and WT and replace the defective component. | |
| 32. Paralleling lights, DS4 and or DS5, will not light with S6 in parallel position | DC relay control circuit assembly (A5) defective. | With set stopped, check resistance between A5 terminals 7 and 8 for DS5, and terminals 19 and 20 for DS4. Resistance should be 7500 ohms ±5.0 percent. If no continuity, replace dc relay board (A5) (para 8-6 and 8-7). |
| 33. Improper governor operation (i.e., load sensing) | Current transformer resistor board (A7) defective. | Measure resistance of R23, R24, and R25 on A7 (located in precise relay box on Class 1, Mode 1 sets - in set special box on other sets). Replace any resistor that does not read 7.5 ohms ±0.5 percent (fig. 8-2 and 8-3). |
| 34. Generator set hunts | Governor resistor board capacitor (C1) defective (Class I only) | Check capacitor (C1) on A6, between pins 5 and 6. Replace a defective capacitor. (60 mfd non-polarized) (fig. 8-4 and 8-5). |
| 35. Main AC contactor (CB2) will not close | a. Defective short circuit relay K13. | a. Check relay K13. Replace if defective (para 8-6 and 8-7). |
| | b. Defective overload reload relay K14. | b. Check relay K14. Replace if defective. |
| | c. Defective reverse power relay K15. | c. Check relay K15. Replace if defective (para 8-6 and 8-7). |
| | d. Defective undervoltage relay K11. (Class I only) | d. Check relay K11. Replace if defective. (para 8-6 and 8-7). |
| | e. Defective underfrequency relay K12. | e. Check relay K12. Replace if defective. (para 8-6 and 8-7). |
| | f. Defective permissive paralleling relay K16. | f. Check relay K16. Replace if defective (para 8-6 and 8-7). |
| | g. Defective contactor switch S3. | g. Check switch S3. Replace if defective. (para 6-2). |

Table 2-2. Generator Set Troubleshooting (Cont)

| Malfunction | Probable cause | Corrective action |
|---|---|---|
| 36. Electric governor not controlling set. (Class I only) | a. Defective electric governor control unit. | a. Isolate (para 7-2). Adjust, repair or replace as required (para 7-2 and 7-4). |
| | b. Low hydraulic pressure. | b. Isolate (para 14-14 and correct trouble. (para 14-15 and 14-16). |
| | c. Defective hydraulic actuator. | c. Isolate (para 13-2). Repair or replace actuator as required (para 13-3 thru 13-5) |
| 37. Generator sets will not parallel and share real (kw) load. | a. Governor is not adjusted correctly. | a. For a Class 1 set, Precise, refer to paragraph 7-2. |
| | b. Fuel injection pump is not adjusted properly. | b. For a Class II set, Utility, refer to paragraph 14-45. |
| 38. Generator sets will not parallel and share reactive load. | Exciter regulator system (including the reactive load sharing potentiometer (R29) is not correctly adjusted. | Refer to paragraph 8-14 for correct adjustment procedures. |

NOTE

Additional troubleshooting procedures are contained in Tables 8-1 and 14-1.

## Section IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS

### 2-10. General.

This section contains instructions for removal and installation of major components of the generator set to facilitate repair and overhaul procedures. Removal of assemblies and repair and overhaul instructions are covered in subsequent sections of this manual.

### 2-11. Generator Removal.

See figure 2-1 for location of major components.

a. Disconnect the ground cable from the battery.

b. To remove the following refer to the Operator and Organizational Maintenance Manual.

(1) Receptacle panels (as required).

(2) Manual speed control.

(3) Fault indicator.

(4) Control cubicle.

(5) Rear grille.

(6) Rear panels and doors.

(7) Rear roof and corner posts.

(8) Main load contactor.

(9) Load terminal board.

(10) Reconnection board.

(11) Air cleaner.

c. See figure 6-2 for removal of main generator leads from current transformer assembly. Before removing current transformer assembly, tag 18 harness wires from terminal strip and identify the leads which are passed through the current transformers more than once.

d. See para 6-8 for removal of current transformer assembly.

e. On Class I sets only, remove the governor control unit and mounting bracket. (See para 7-3.)

f. Remove the relay table group. (See para 8-5.)

g. Remove generator. See figure 2-2 and proceed as follows:

(1) Position engine jacking supports on the engine flywheel housing. Adjust engine jacking studs by hand until firm contact is established with skid base.

(2) Insert generator lifting eye bolt in top of generator housing and attach suitable lifting device.

(3) Remove two screws and two flat washers and two lockwashers on each side of generator housing near forward end and remove access cover and screen.

(4) Remove 4 generator mounting screws, 8 washers and 4 nuts.

(5) Adjust jacking studs to support the weight of the engine, approximately 1/2 turn beyond hand tight.

(6) Reaching through inspection holes in generator housing, bend lockstrips away from heads of eight fan-coupling screws securing generator coupling. Remove the screws to separate the engine and generator at the coupling. Removal of these screws also frees the fan. To facilitate access to the screws, rotate the engine.

(7) Reaching through inspection holes in forward end of generator, remove 12 rim coupling screws and washers around perimeter of flange mating engine to flywheel housing.

### 2-12. Generator Installation.

a. Using a suitable lifting device, position main generator mounting pads in skid base and line up generator mounting flange with flywheel housing.

b. Install 12 screws and washers through generator front flange into flywheel housing. Torque screws to 35 foot-pounds.

c. Reach through generator inspection holes, support fan to line up holes and install eight fan coupling screws each with a lockstrip. Before tightening make sure lockstrip extension is in small hole adjacent to threaded screw hole. Torque bolts to 110 foot-pounds. Bend lockstrip corners against screw head flats.

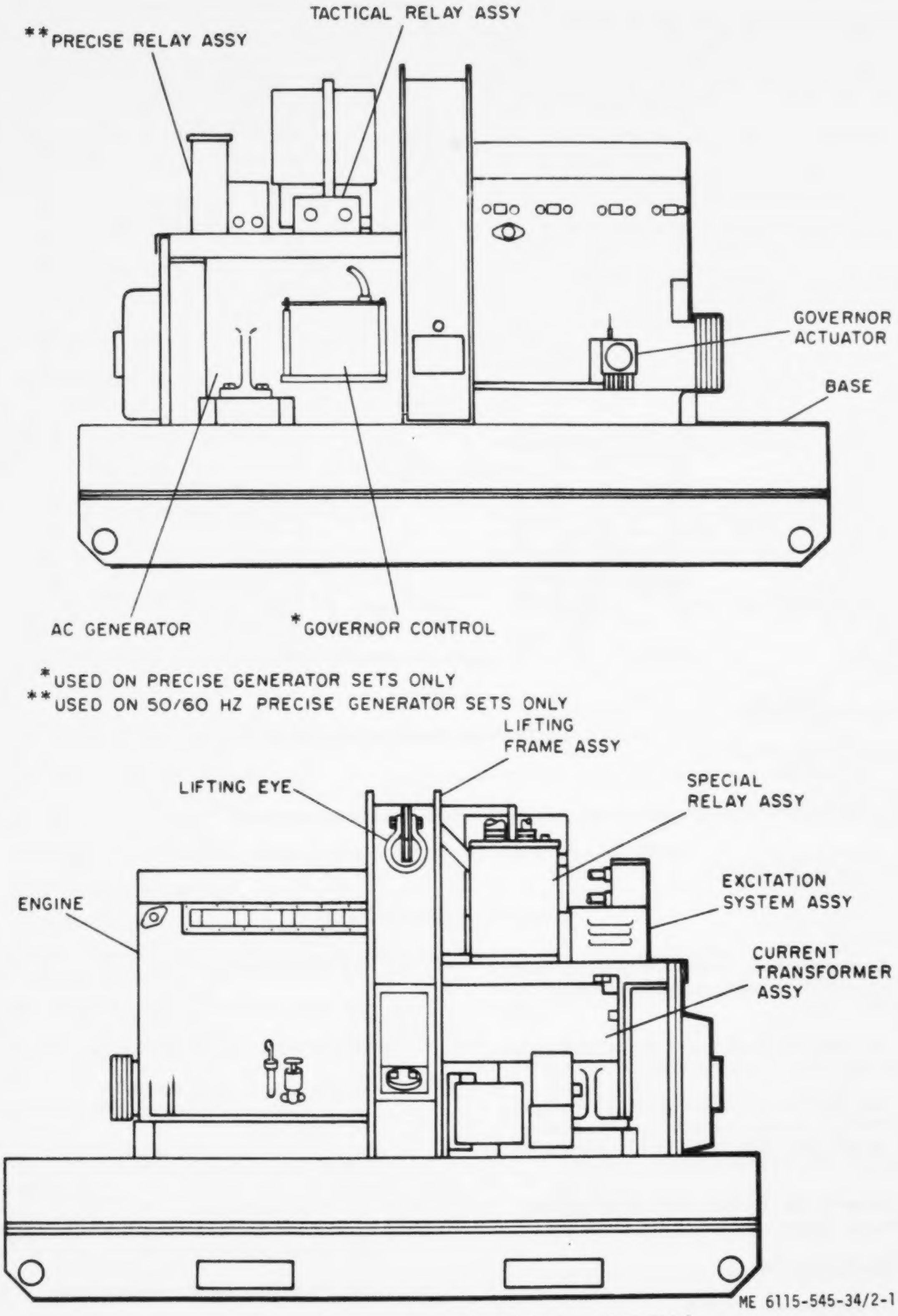
d. Install four main generator mounting screws and washers and secure with four nuts and 8 washers. Do not torque screws at this time.

e. Loosen and remove engine support brackets.

f. Torque generator mounting screws to 440 foot-pounds.

g. Install screen and access cover on generator and secure with two screws, two flat washers, and two lockwashers on each side.

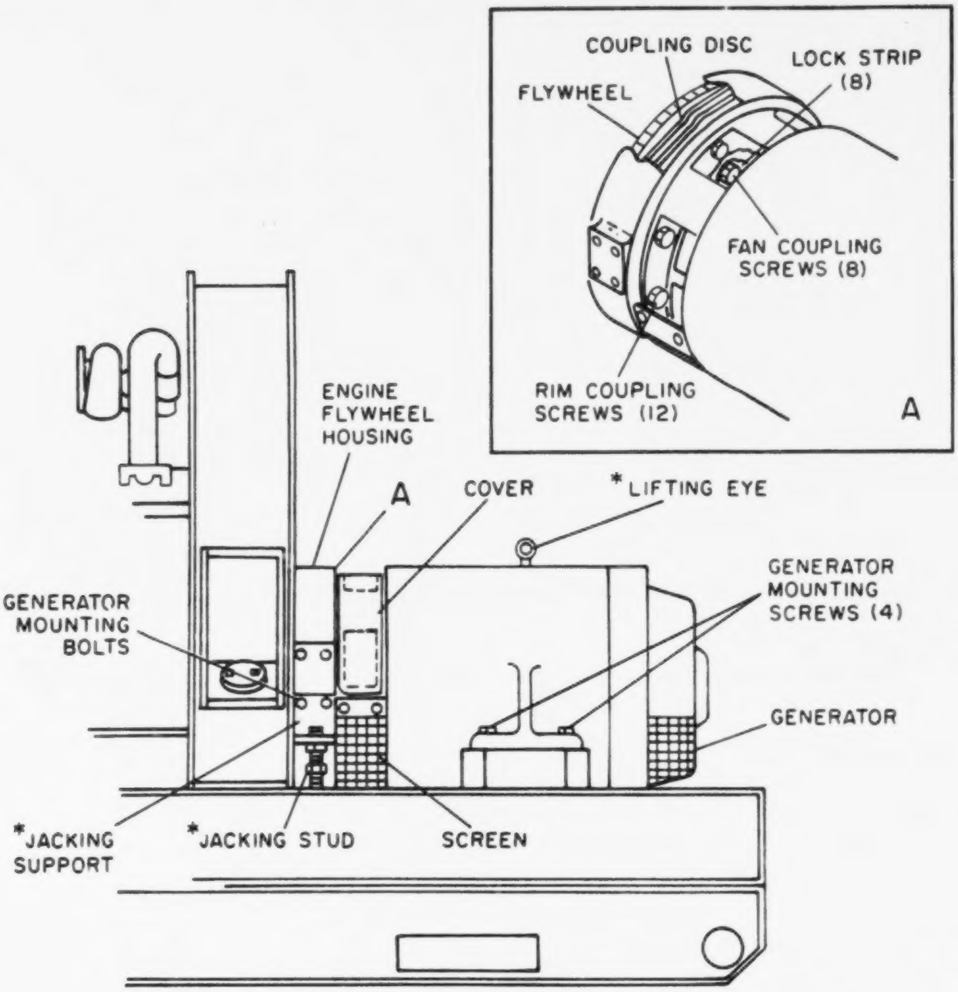
h. See figure 8-1 and install relay table group in reverse order of removal.


**PRECISE RELAY ASSY
TACTICAL RELAY ASSY
GOVERNOR ACTUATOR
BASE
AC GENERATOR
*GOVERNOR CONTROL
LIFTING FRAME ASSY
LIFTING EYE
SPECIAL RELAY ASSY
ENGINE
EXCITATION SYSTEM ASSY
CURRENT TRANSFORMER ASSY
ME 6115-545-34/2-1

*USED ON PRECISE GENERATOR SETS ONLY

**USED ON 50/60 HZ PRECISE GENERATOR SETS ONLY

Figure 2-1. Component Locations (Right and Left Side)


COUPLING DISC
LOCK STRIP (8)
FLYWHEEL
FAN COUPLING SCREWS (8)
RIM COUPLING SCREWS (12)
A
ENGINE FLYWHEEL HOUSING
A
COVER
*LIFTING EYE
GENERATOR MOUNTING BOLTS
GENERATOR MOUNTING SCREWS (4)
GENERATOR
*JACKING SUPPORT
*JACKING STUD
SCREEN

NOTE: *ITEMS LOCATED IN TOOL BOX UNDER ACTUATOR

ME 6115-545-34/2-2 C1

Figure 2-2. Generator Removal

i. On precise sets, install the governor control unit and mounting bracket in reverse order of removal (fig. 7-1).

j. See figure 6-3 and install the current transformer assembly in reverse order of removal.

k. See figure 6-2 and thread generator output cables through current transformers in reverse order of removal. Connect 18 tagged harness wires to terminal strip on transformer assembly.

l. Refer to the Operator and Organizational Maintenance Manual and install the following:

(1) Air cleaner.

(2) Reconnection board.

(3) Load terminal board.

(4) Main load contactor.

(5) Rear roof and corner posts.

(6) Rear panels and doors.

(7) Rear grill.

(8) Control cubicle.

(9) Fault indicator.

(10) Manual speed control.

(11) Receptacle panels (as required).

m. Connect tagged cables and harness wires to lugs on rear of voltage reconnection panel. Mount reconnection board with attaching hardware on left side. Right side of panel will attach to load contactor. Reconnect the ground cable to the battery.

n. If the generator has been renewed or repaired refer to Chapter 16, Section II and conduct the following tests.

(1) Phase balance test.

(2) Regulator and governor stability and transit response.

2-13. Engine Removal.

a. Drain the engine cooling and lube systems and the hydraulic sump, as instructed in the Operators and Organizational Maintenance Manual.

b. Disconnect the ground from the batteries.

c. Drain fuel from the day tank and secondary fuel filters.

d. Refer to the Operator and Organizational Maintenance Manual for sequential removal of the following items:

(1) Crankcase breather cover and tubing.

(2) Rain cap and exhaust system.

(3) Receptacle panels.

(4) Housing and cooling groups.

(5) Manual speed control.

(6) Interconnecting wiring harnesses.

(7) Fuel filters, day tank, mounting bracket, and related fuel lines.

(8) Engine drain lines.

(9) On precise sets only, hydraulic sump and filter.

(10) Winterization kits (if installed).

e. Remove all components of the relay table group and load connection group as instructed in paragraph 2-11.

f. Remove the top bracket from the lifting frame assembly. (fig. 11-1)

g. Position jacking studs under rear of engine and adjust to support engine weight (fig. 2-2). Remove four fan coupling screws (para 2-11) which are to be used as attaching hardware for the jacking support bracket. Remove alternate fan coupling screws only at this time.

h. Attach suitable lifting device to engine hoist brackets.

i. Uncouple generator from engine (para 2-11). Remove the remaining four coupling screws.

j. Remove two screws securing engine front mounting bracket to skid base (fig. 2-3).

k. Hoist engine up and forward to clear generator, and lift out of skid base. Place engine on flat surface with a supporting block under front support or place in engine support stand.

2-14. Engine Installation.

a. Place jacking studs on engine flywheel housing with mounting hardware.

b. Hoist engine with suitable lifting device and lower engine into mounting position.

c. As engine front mounting bracket nears engagement with skid base, adjust jacking studs, lower engine until it rests on the skid base and its flywheel housing mates with generator front mating flange.

d. Secure front mounting bracket with attaching hardware. Torque engine mount bolts to 90-100 foot-pounds.

e. Couple engine to generator.

f. Install relay table with attaching hardware.

g. Install control relay boxes and excitation system assembly with attaching hardware.

h. Install top bracket with attaching hardware. (fig. 11-1.)

i. Install housing. Refer to the Operator and Organizational Maintenance Manual and install the following:

(1) Winterization kits (if installed).

(2) On precise sets only, hydraulic sump and filter.

(3) Engine drain lines.

(4) Fuel filters, day tank, mounting bracket and related fuel lines.

(5) Interconnecting wiring harnesses.

(6) Manual speed control.

(7) Housing and cooling groups.

(8) Receptacle panels (as applicable).

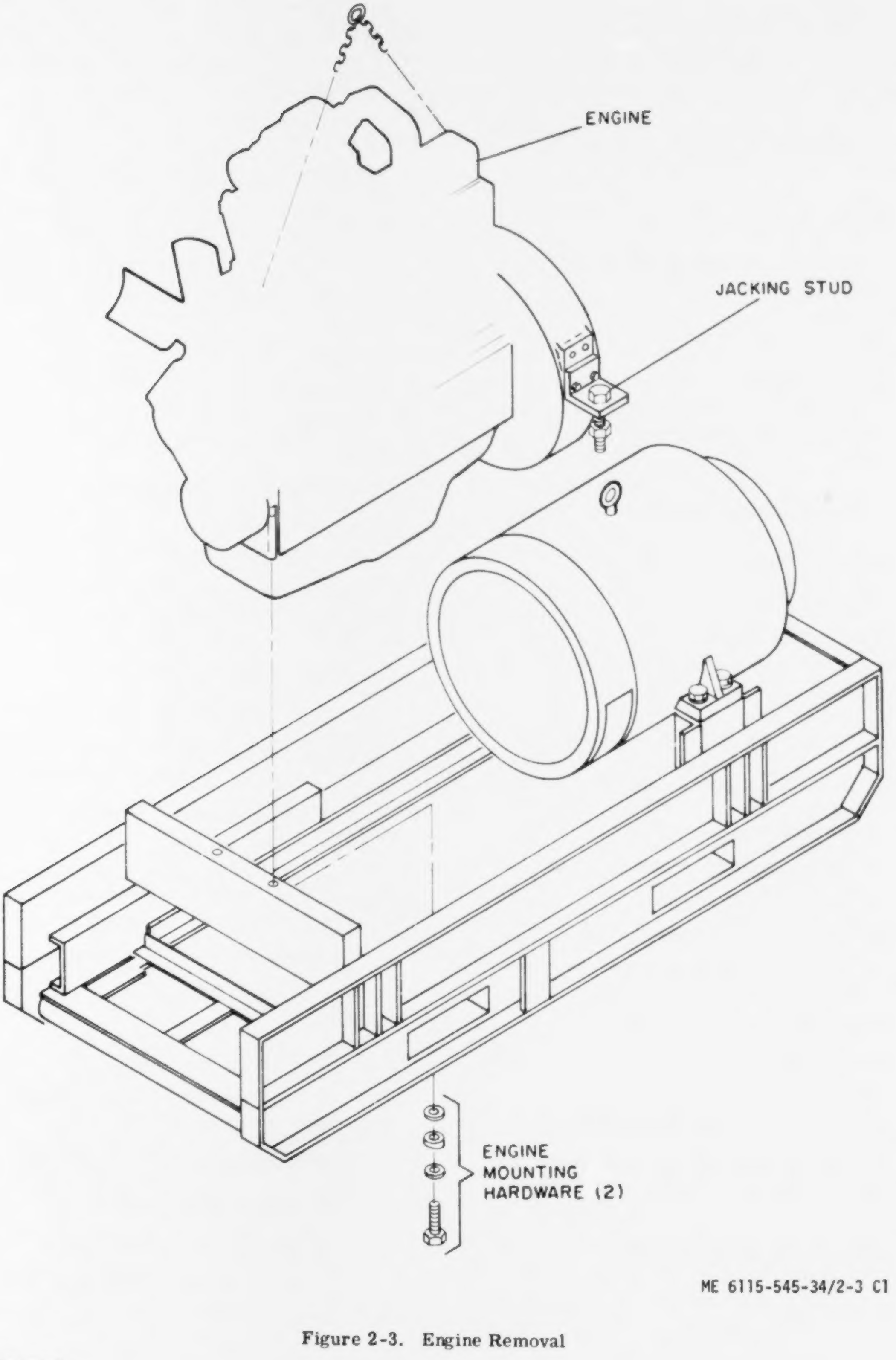

ENGINE
JACKING STUD
ENGINE MOUNTING HARDWARE (2)
ME 6115-545-34/2-3 C1

Figure 2-3. Engine Removal

(9) Rain cap exhaust system.

(10) Crankcase breather cover and tubing.

### 2-15. Engine Generator Assembly Removal.

a. Follow all instructions for disassembly given in paragraphs 2-11a thru 2-11f and 2-13a thru 2-13f.

b. Insert the lifting eye in the socket on top of the generator.

c. Attach a suitable lifting device to the front engine hoist bracket and the generator lifting eye. (fig. 2-4.)

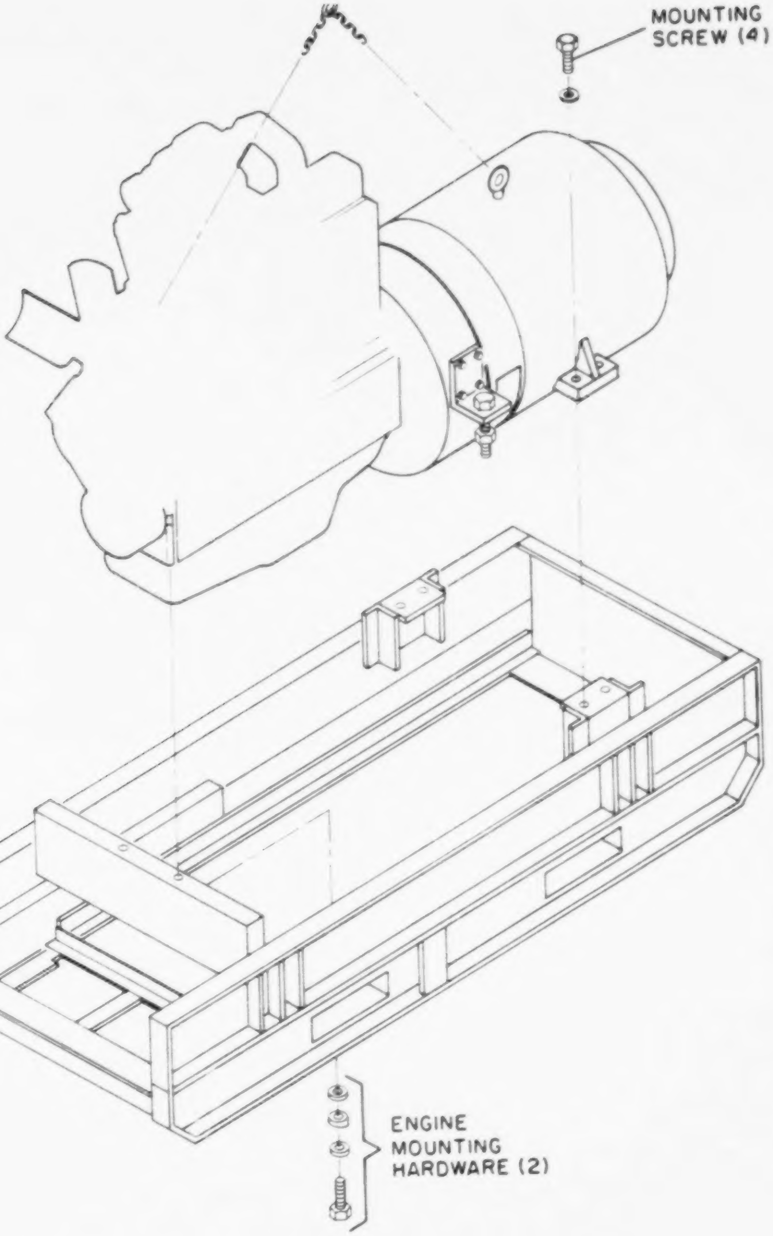
d. Remove the four screws securing the generator to the skid base.

e. Remove two screws securing the engine front support to the skid base.

f. Hoist assembly up and out of skid base. Place on a flat surface with supporting block under engine front support.

### 2-16. Engine Generator Assembly Installation.

Install and reassemble in reverse order of removal. Torque engine mount bolts to 90-100 foot-pounds and generator mounting bolts to 440 foot-pounds.


MOUNTING SCREW (4)
ENGINE MOUNTING HARDWARE (2)

ME 6115-545-34/2-4

Figure 2-4. Engine Generator Removal

# CHAPTER 3

# GENERATOR SET CONTROLS REPAIR INSTRUCTIONS

## Section I. INTRODUCTION

### 3-1. General.

This chapter includes repair instructions for the fault indicator panel and the control cubicle. Test procedures for the control cubicle include individual tests for the converter, control box, relay assembly, frequency meter and transducer, ac wattmeter and ac ammeter.

### 3-2. Generator Set Controls Description.

The generator set controls are mounted at the rear of the set, and provide all monitoring and control devices required to operate the set. Controls consist of the fault indicator panel, the control cubicle, and the manual throttle control. Refer to the Operator and Organizational Maintenance Manual for manual throttle control repair instructions.

## Section II. FAULT INDICATOR PANEL

### 3-3. Removal, Disassembly and Repair.

a. Removal. Refer to Operator and Organizational Maintenance Manual and remove the fault indicator panel.

b. Disassembly. See figures 3-1 and 3-2 and disassemble the fault indicator panel.

c. Repair. Proceed as follows:

(1) Clean all components with low pressure compressed air, or wipe clean with dry, lint free cloth.

(2) Inspect for broken fuseholders, cracked or broken lamp holders, damaged wire insulation, broden wires and bent or broken connector pins.

(3) Remove any components that show visual damage, such as broken fuseholder, or broken lamp holder (fig. 3-1).

(4) Replace circuit board if broken, cracked or distorted.

(5) Resistors may be checked by breaking connection at one end to prevent feedback resistance and touching both ends with ohmmeter probes. Resistors R1 through R10 (fig. 1-2) should read 2.2K ohms ± 10 percent. Resistors R11 through R20 should read 1K ohms ± 10 percent. Any variation in excess of 10 percent indicates that the resistor should be replaced. If any connections are opened or bared for test purposes or if any defective components are replaced, the affected area must be coated with polyurethane resin to prevent oxidation or other corrosion. The coating must be of a minimum thickness of 0.007 inches and air bubble entry into the applied polyurethane must be controlled so that the legibility of component coding and identification is not impaired. The polyurethane resin to be utilized will correspond to MIL-I-46058 grade S, Type PUR.

(6) Unplug relay 17, (fig. 3-1) in fault indicator panel and check resistance of relay coils with ohmmeter probes across pins 3 and 7. Reading should be 300 ohms ± 10 percent. Replace relay if variation exceeds 10 percent. Plug relay into circuit board.

(7) Rebuild wiring harness if inspection reveals 30 percent or more defective wires. Wiring harness rebuilding instructions are described in Chapter 5. Otherwise replace damaged wires.

### 3-4. Reassembly, Testing and Installation.

a. Reassembly. See figures 3-1 and 3-2 and reassemble the fault indicator panel.

b. Testing. See figure 1-2. To test the fault indicator panel, proceed as follows:

(1) Connect 24Vdc, positive to pin A of terminal board.

(2) Connect 24Vdc negative to pin B and case.

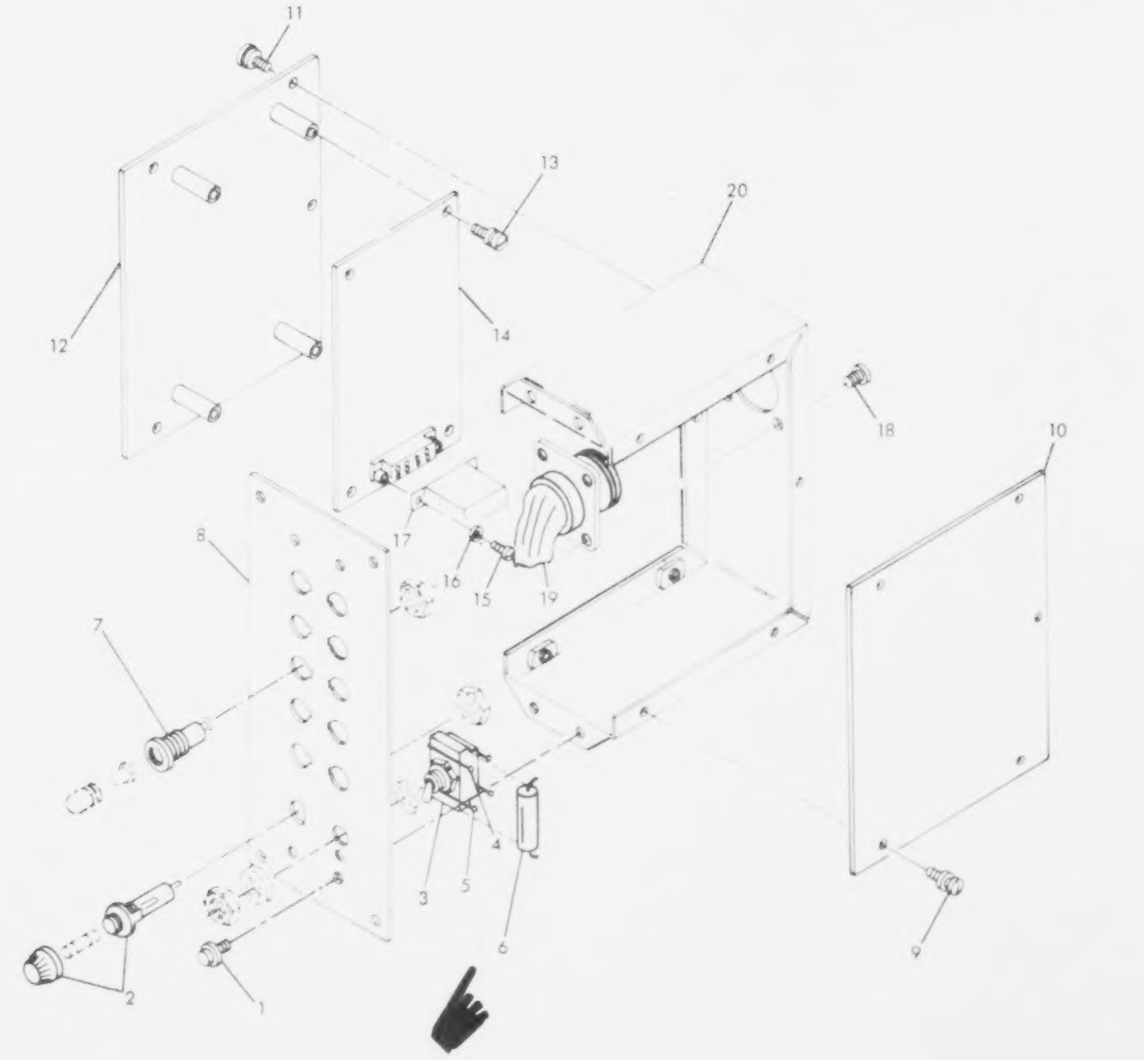
(3) Operate reset switch. All lights should light.

(4) Connect pin C to pin D. Low oil pressure light should light.

(5) Open C to D connection. Low oil pressure lights should remain on.

(6) Connect pin C to pin E. Low oil pressure light should remain on.

(7) Operate reset switch. Low oil pressure light should go out and overspeed switch should light.


11
13
20
12
14
18
10
8
17
16
15
19
7
4
3
5
6
9
2
1

1. Screw
2. Fuseholder
3. Switch
4. Tiedown strap
5. Tiedown strap

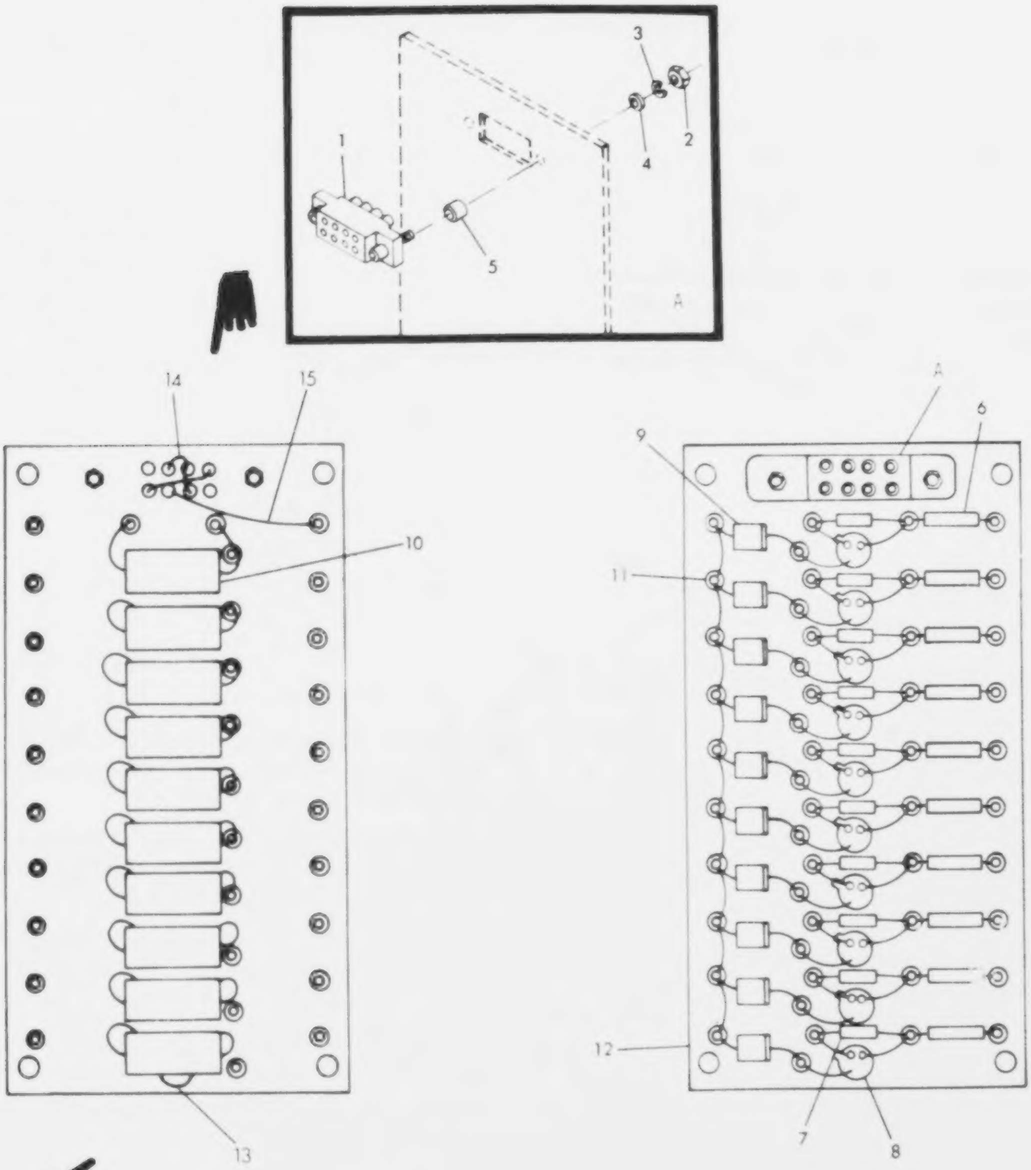
■ 6. Capacitor
7. Lampholder
8. Cover
9. Screw
10. Cover

11. Screw
12. Plate assembly
13. Screw
14. Component board assembly
15. Screw

16. Washer
17. Relay
18. Screw
19. Wiring harness
20. Chassis

ME 6115-545-34/3-1 C7

Figure 3-1. Fault Locating Indicator


3
2
1
4
5
A
14
15
10
A
6
9
11
12
13
7
8

1. Socket
2. Nut
3. Washer
4. Washer
5. Spacer
6. Resistor
7. Resistor
8. Rectifier
9. Rectifier
10. Capacitor
11. Terminal
12. Board
13. Insulation
14. Wire
15. Wire

ME 6115-545-34/3-2 C7

Figure 3-2. Assembly, Fault Indicator

(8) Repeat paragraphs (5), (6), and (7) above for other lights, connecting pin C to pins F, G, H, I, K, L, M, and N.

c. Installation. Refer to Operator and Organizational Maintenance Manual and install the fault indicator.

## Section III. CONTROL CUBICLE

### 3-5. Removal, Disassembly and Repair.

WARNING

> To avoid serious injury to personnel before doing any work in the control cubicle, be sure all power circuits are disconnected. Never work in the control cubicle while the engine is running. Killing voltages are present.

a. Removal. Refer to Operator and Organizational Maintenance Manual and remove the control cubicle.

b. Disassembly. Refer to Operator and Organizational Maintenance Manual and disassemble the control cubicle. See figure 3-3 and disassemble the relay assembly.

c. Repair. Proceed as follows:

(1) Clean all components with low pressure compressed air, or wipe clean with dry, lint free cloth.

(2) Inspect for broken fuseholders, cracked or broken lamp holders, damaged meters, broken terminals on components, damaged wire insulation, broken wires and bent or broken connector pins.

(3) Replace any components which show visual damage, such as cracked or broken meters, broken lamp holders, or cracked or broken switches and rheostats.

(4) Inspect control panel relay assembly for damage. Replace component (fig. 3-3) if damage is evident. If any connections are opened or bared for test purposes, or if any defective components are replaced, the effected areas and components must be coated with polyurethane resin to prevent oxidation or other corrosion. The coating must be a minimum of 0.007 inches and air bubble entry into the applied polyurethane must be controlled so that the legibility of component coding and identification is not impaired. The polyurethane resin to be utilized will correspond to MIL-I-46058 grade S, Type PUR.

### 3-6. AC Wattmeter Convertor Testing.

To test the ac wattmeter of the control cubicle proceed as follows:

a. Connect a master 3-phase wattmeter of known accuracy (1/2 of 1 percent) and a suitable variable load to the output of terminal lugs of the generator set.

b. Start the generator set.

c. Vary load and compare the readings of the ac wattmeter on the set with readings of the master wattmeter.

d. The operating set wattmeter error must not exceed 10 percent of full scale value. If it does, replace the ac wattmeter. If it does not, proceed to para 3-7.

### 3-7. Transducer Testing.

To test the control cubicle watt transducer, proceed as follows:

a. Connect the watt transducer to the test equipment as illustrated in figure 3-4. Use a calibrated % of rating meter.

b. Adjust all autotransformers T1, T2 and T3 to their MIN positions.

c. Close switch S1 and open switches S2 and S3.

d. Energize the power source.

e. Adjust T1 until 600 miliamperes is indicated on ammeter A1. The % of rating meter of known accuracy should indicate approximately 33%.

f. Close switch S2 and adjust T2 until 600 miliamperes is indicated on ammeter A2. The % of rating meter should indicate approximately 66%.

g. Close switch S3 and adjust T3 until 600 miliamperes is indicated on ammeter A3. The % of rating meter of known accuracy should indicate 100%.

h. Replace the thermal watt transducer if it does not satisfy the above requirements.

i. If the transducer meets the above requirements, replace the wattmeter.

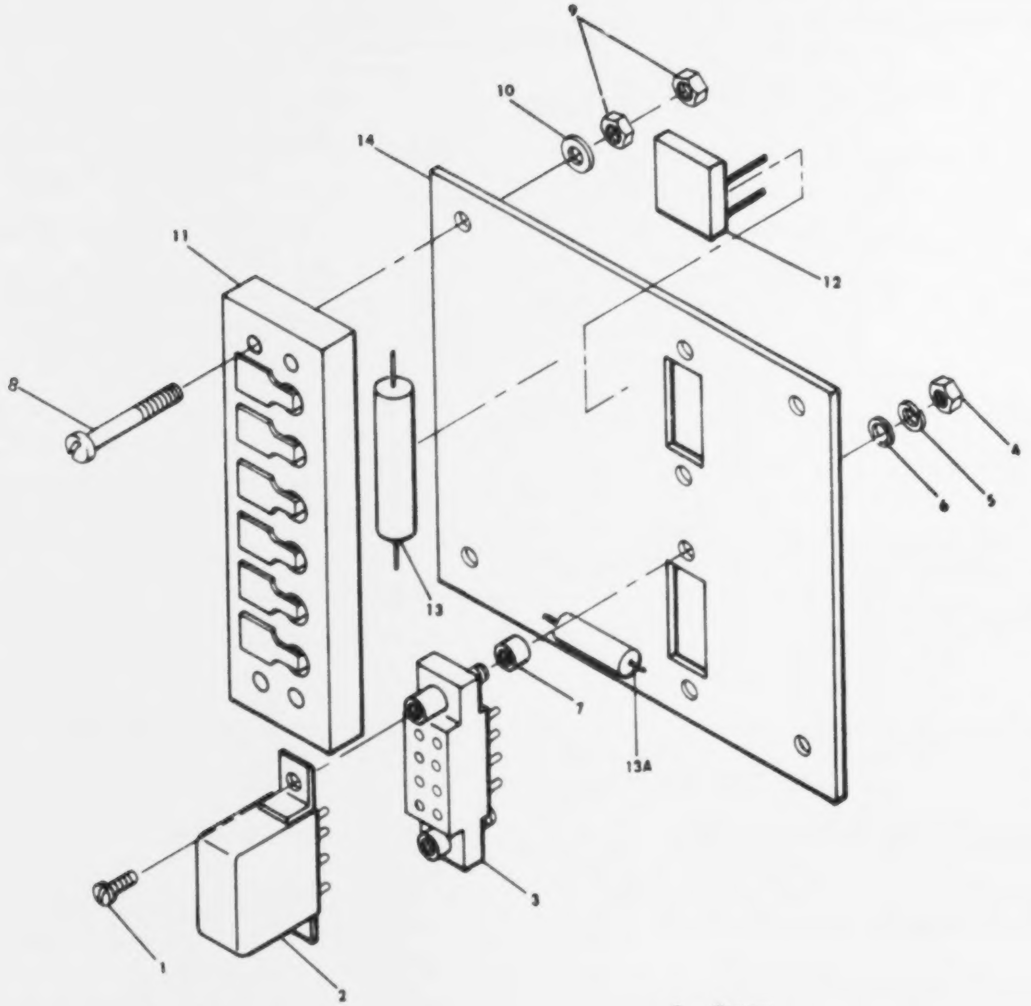
### 3-8. AC Ammeter Testing.

To test the ac ammeter of the control cubicle, proceed as follows:

a. Connect a suitable master ac current meter in series with the set ac current meter.

b. Start the unit and connect a variable load to the output terminals and compare the readings of the two meters.

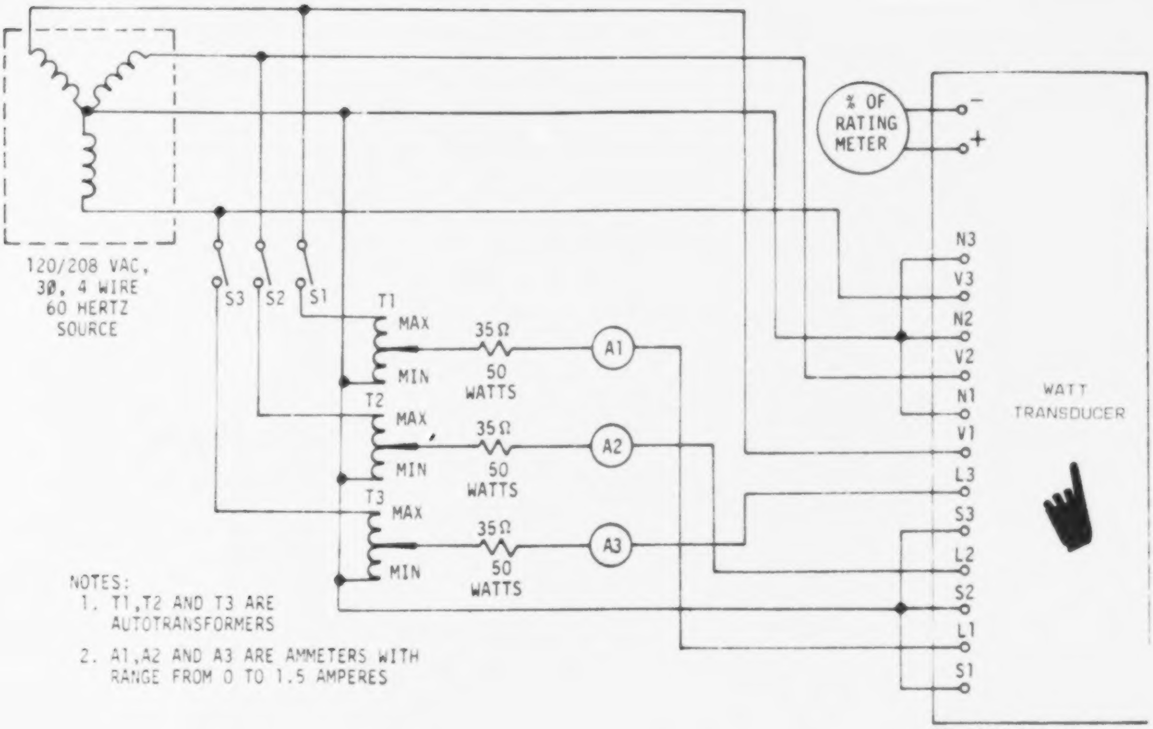
c. The generator set ac ammeter error must not be greater than 2 percent of full scale value. If it is, replace the ac ammeter.


9
10
14
11
12
8
4
5
6
13
7
13A
3
1
2

1. Screw
2. Relay
3. Socket
4. Nut
5. Washer
6. Washer
7. Spacer
8. Screw
9. Nut
10. Washer
11. Terminal board
12. Rectifier
13. Resistor
13A. Capacitor
14. Board

ME 6115-545-34/3-3 C1

Figure 3-3. Relay Assembly



NOTES:
1. T1,T2 AND T3 ARE AUTOTRANSFORMERS
2. A1,A2 AND A3 ARE AMMETERS WITH RANGE FROM 0 TO 1.5 AMPERES

ME 6115-545-34/3-4

Figure 3-4. Control Cubicle Transducer, Test Setup

## 3-9. Frequency Meter and Transducer Test.

To test the frequency meter and transducer of the control cubicle, proceed as follows:

### NOTE

The frequency meter and transducer are a matched set and must be tested as a set.

a. Connect a variable frequency 120 Vac sinusoidal input to the ac side of the frequency transducer.

b. Connect a master frequency meter across the input. The master frequency meter shall have an accuracy of a minimum of 3/4% or greater of the set frequency meter and transducer (1/20 of 1 percent).

c. Vary the frequency from lowest scale reading to full scale reading.

d. The error at any point on frequency meter shall not be greater than 1 percent.

e. If the above requirements are not satisfied, replace both the frequency meter and transducer.

## 3-10. Control Box Relay Testing.

To test the control box relay assembly of the control cubicle (see figure 1-1) and proceed as follows:

### CAUTION

When applying the 120 Vac to control box relay assembly terminals, insure correct placement of power supply leads. Damage to other components could result if leads are inadvertently misplaced.

a. With no power applied, check continuity across following terminals of the control box relay assembly: terminals 10 and 11; 5 and 6; and 1 and 3 (fig. 1-1).

b. Apply a dc voltage of 24 volts to terminals 2 and 8. The normally open contacts between terminals 7 and 9, and the normally closed contact between terminals 1 and 3 should transfer (fig. 1-1).

c. Apply an ac voltage from 50 to 80 volts, 50/60 Hz or 400 Hz to terminals 4 and 12. The normally open contacts between terminals 4 and 6, and terminals 10 and 12 and the normally closed contacts between terminals 5 and 6, and terminals 10 and 11 should transfer (fig. 1-1).

d. Connect 120 Vac 60 Hz power supply to terminals 4 and 12 of the control box relay assembly. Measure voltage at terminals 6 and 10. Voltage should be 120 Vac (fig. 1-1).

e. Measure dc voltage across relay K6. Voltage should be above 18 Vdc (fig. 1-1).

## 3-11. Control Cubicle Wiring Harness.

Rebuild wiring harness if inspection reveals 30 percent or more defective wires. Wiring harness rebuilding instructions are described in Chapter 5. Otherwise replace damaged wires.

## 3-12. Control Cubicle Reassembly, Testing and Installation.

a. Reassembly. Refer to Operator and Organizational Maintenance Manual and reassemble the control cubicle.

b. Testing. Refer to the Operator and Organizational Maintenance Manual (Control cubicle, schematic diagram) to test the assembled control cubicle.

(1) The following control cubicle component tests are described in paragraphs 3-6 through 3-10 respectively.

Ac Wattmeter
Converter
Ac Ammeter
Frequency meter and transducer
Control box relays

(2) Wiring test.

(a) Using an ohmmeter, check the wiring from each pin of receptacle J1 to the last point of its connection.

(b) Where the wiring of two or more pins of the receptacle can be tested by a switch closure, close the switch and complete the test. After completing the test, return the switch to its normal position.

(3) Oil pressure gage test.

(a) Connect the positive lead of a variable dc power supply, adjusted for 28.5 Vdc, to pin small w of receptacle J1.

(b) Connect the negative lead of the power supply via a 0-50 ohm 100 watt potentiometer adjusted for 15 ohms to pin V or receptacle J1.

(c) Turn on the power supply and wait 3 minutes.

(d) After 3 minutes have elapsed, the oil pressure gage should indicate 60 psi.

(e) Turn off the power supply and disconnect the test circuit.

(4) Water Temperature gage test.

(a) Connect the positive lead of a variable voltage dc power supply, adjusted for 28.5 Vdc, to pin small w of receptacle J1.

(b) Connect the negative lead of the power supply via a 0-2K ohm 5 watt potentiometer adjusted for 917 ohms, to pin W of receptacle J1.

(c) Turn on the power supply and wait 3 minutes.

(d) After 3 minutes have elapsed, the water temperature gage should indicate 180 degrees F.

(e) Turn off the power supply and disconnect the test circuit.

(5) Fuel Level gage test.

(a) Connect the positive lead of a variable voltage dc power supply adjusted for 28.5 Vdc, to pin small w of receptacle J1.

(b) Connect the negative lead of the power supply via a 0-50 ohm 100 watt potentiometer adjusted for 15 ohms to pin X of receptacle J1.

(c) Turn on the power supply and wait 3 minutes.

(d) After 3 minutes have elapsed, the fuel level indicator should indicate one-half tank.

(e) Turn off the power supply and disconnect the test circuit.

(6) Total Time indicator test.

(a) Connect the positive lead of a variable voltage dc power supply adjusted for 28.5 Vdc, to pin small w of receptacle J1.

(b) Connect the negative lead of the power supply to pin small r of receptacle J1.

(c) Turn on the power supply.

(d) Observe the tenths column of the indicators digital read out.

(e) The indicator shall display one-tenth after six minutes of operation.

(f) Turn off the power supply and remove the test leads.

(7) Panel light test.

(a) Connect the positive lead of a variable voltage dc power supply, adjusted for 24 Vdc, to pin small v of receptacle J1.

(b) Connect the negative lead of the power supply to pin small r of receptacle J1

(c) Place the PANEL LIGHT switch to the ON position and observe the illumination of three panel lights.

(d) Place the PANEL LIGHT switch to the OFF position.

(e) Turn off the power supply and disconnect the test leads.

(8) Air cleaner condition light test.

(a) Connect the positive lead of a variable voltage dc power supply, adjusted for 24 Vdc to pin small c of receptacle J1.

(b) Connect the negative lead of the power supply to pin small r of receptacle J1.

(c) Turn on the power supply.

(d) The AIR CLEANER CONDITION light does not illuminate.

(e) Depress the AIR CLEANER CONDITION light, the light illuminates.

(f) Turn off the power supply and connect the positive lead to pin small u of receptacle J1.

(g) Turn on the power supply.

(h) The AIR CLEANER CONDITION light illuminates.

(i) Turn off the power supply and disconnect the test leads.

(9) Circuit breaker light test.

(a) Connect the positive lead of a variable voltage dc power supply, adjusted for 24 Vdc, to pin small v of receptacle J1.

(b) Connect the negative lead of the power supply to pin small r of receptacle J1.

(c) Turn on the power supply.

(d) The CKT. BRKR. light does not illuminate.

(e) Depress the CKT. BRKR. light, the light illuminates.

(f) Turn off the power supply and connect the positive lead to pin small a of receptacle J1.

(g) Turn on the power supply.

(h) The CKT. BRKR. light illuminates.

(i) Turn off the power supply and disconnect the test leads.

(10) Battle short light test.

(a) Connect the positive lead of a variable voltage dc power supply adjusted for 24 Vdc, to pin small v of receptacle J1.

(b) Connect the negative lead of the power supply to pin small r of receptacle J1.

(c) Turn on the power supply.

(d) The BATTLE SHORT light does not illuminate.

(e) Depress the BATTLE SHORT light, the light illuminates.

(f) Turn off the power supply and connect the positive lead to pin R of receptacle J1.

(g) Place the BATTLE SHORT switch to the ON position, the BATTLE SHORT light illuminates.

(h) Place the BATTLE SHORT switch to the OFF position.

(i) Turn off the power supply and disconnect the test leads.

(11) Synchronizing lamp test

(a) Connect one lead of a 120 Vac power supply to pin J of receptacle J1.

(b) Connect the remaining lead of the power supply to pin G of receptacle J1.

(c) Turn on the power supply.

(d) Place the unit operation switch to the PARALLEL position.

(e) One of two synchronizing lamps (DS4) shall illuminate.

(f) Place the unit operation switch to the single unit position.

(g) Turn off the power supply and disconnect the test leads.

(h) Repeat the procedure b (11) (a) through (g) for the second synchronizing lamp (DS5) utilizing pins K and H of receptacle J1.

(12) DC ammeter test

(a) Connect a Simpson 260 or equivalent

ohmmeter, with the R x 10,000 scale selected, to pins Z and Y of receptacle J1.

(b) With the positive lead connected to pin Y and the negative lead to pin Z, the ammeter will read approximately 6 amperes up scale.

(c) Reverse the connections at receptacle J1 so that the positive lead is connected to pin Z and the negative lead is connected to pin Y.

(d) The ammeter will read approximately 6 amperes down scale.

(e) Disconnect the ohmmeter and test leads.

(13) Voltage adjusting rheostat test

(a) Connect a Simpson 260 or equivalent ohmmeter, with the R x 100 scale selected, across pins small z and large U of receptacle J1.

(b) Place the VOLTAGE SENSING switch to the LOCAL position.

(c) Rotate the VOLTAGE ADJUST rheostat from stop to stop, the resistance will vary from 0 to 250 ± 10 percent ohms.

(d) Rotate the VOLTAGE ADJUST rheostat until 125 ohms are indicated on the ohmmeter and disconnect the test leads.

(14) Frequency adjust rheostat test

(a) Connect a Simpson 260 or equivalent ohmmeter, with the R x 100 scale selected, across pins N and T of receptacle J1. The resistance indicated should be 500 ohms ± 10 percent.

(b) Remove the test lead from pin T and place it in pin M.

(c) Rotate the FREQUENCY ADJUST rheostat from stop to stop, the resistance should vary from 0 to 500 ± 10 percent ohms.

c. Installation. Refer to Operator and Organizational Maintenance Manual and install the control cubicle.

# CHAPTER 4

## HOUSING GROUP REPAIR INSTRUCTIONS

### 4-1. General.

The engine generator set housing provides a protective enclosure during set operation or storage. Doors permit sufficient access to all areas of the engine generator set for operating and routine maintenance procedures.

### 4-2. Housing Removal and Cleaning.

Refer to Operator and Organizational Maintenance Manual.

### 4-3. Housing Inspection, Servicing, and Repair.

a. Refer to Operator and Organizational Maintenance Manual for inspection and servicing procedures.

b. Repair any minor sheet metal dents in doors, covers, and panels.

c. Sheet metal tears can be repaired by welding.

d. Paint scratches that reveal bare metal or paint that is removed during repair should be touched up as follows:

(1) Smooth edges of remaining paint with fine sandpaper.

(2) Clean area with Federal Specification P-D-680 solvent and wipe dry with clean cloth.

(3) Treat area and paint in accordance with service requirements.

e. Replace any cover, door, panel, or hardware that is damaged beyond repair.

### 4-4. Housing Installation.

Refer to Operator and Organizational Maintenance Manual.

# CHAPTER 5

# WIRING HARNESS REPAIR INSTRUCTIONS

## 5-1. General.

Electrical interconnection of control devices and indicators is accomplished through wiring harnesses. Wires in the harnesses are bundled and secured to prevent unnecessary movement and chafing, and to conserve space. Internal wiring harnesses for the relay boxes, kits and other electrical assemblies are also provided in this section.

## 5-2. Wiring Harness Removal and Inspection.

a. Refer to Operator and Organizational Maintenance Manual for harness removal procedures.

b. Refer to Operator and Organizational Maintenance Manual for inspection procedures.

## 5-3. Wiring Harness Repair and Rebuild.

a. Repair.

(1) Repair procedures for individual wires are covered in the Operator and Organizational Maintenance Manual.

(2) If a wiring harness has sustained damage to 30 percent or more of the wires in the harness, the wiring harness must be completely rebuilt.

b. Rebuild.

(1) Figures 5-1 through 5-40 are illustrations of the wiring harnesses installed on the generator set.

(2) Each illustration includes a wire run list providing wire origination, destination, identification number, wire length, and preparation requirements, and end preparation. Find numbers (circled) related to specific components.

(3) Refabricate a new wire harness using the illustration for dimension and the wire run list for proper wire connection.

(4) If a wiring harness cannot be identified, compare it with the illustrations until proper identification is made. Check numbers stamped on wires against those in the wire run list to insure proper identification before proceeding with refabrication.

(5) Wiring shall be neatly laced through the use of self-locking nylon straps, located at intervals not to exceed three inches, and also at each wire break out.

(6) Soldering shall be in accordance with requirement 5 of MIL-STD-454 using SN60 solder.

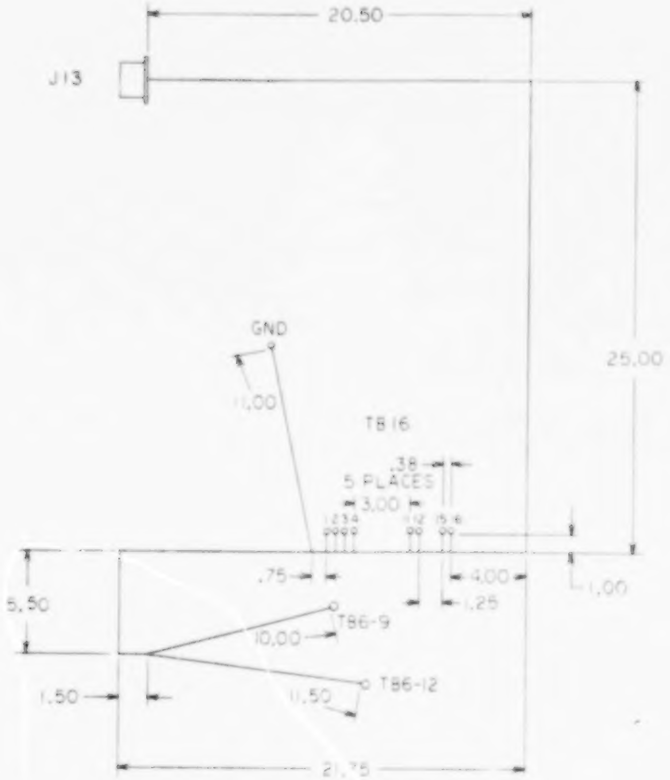
(7) Wire numbering shall be in accordance with MIL-W-5088, except that length between adjacent groups of numbers shall not exceed six inches.

(8) Cut insulation tubing in one-half inch pieces and install around wires at pins of connectors and receptacles.

(9) Install nylon filler plugs MS25251-16 in unused openings of connectors.

## 5-4. Installation.

Refer to Operator and Organizational Maintenance Manual for installation procedures.



| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| D13A16 | 16 | 61.00 | BLK MKG | P13-A | SOLDER | TB16-11 | ③ |
| D13K16 | ↑ | 53.25 | ↑ | P13-F | ↑ | TB16-12 | ↑ |
| D14A16 |  | 57.00 |  | P13-C |  | TB16-3 |  |
| D14K16 |  | 56.50 |  | P13-B |  | TB16-4 |  |
| D15A16 |  | 58.00 |  | P13-E |  | TB16-1 | ↓ |
| D15K16 |  | 57.50 |  | P13-D |  | TB16-2 | ③ |
| X9J16C |  | 95.00 | ↓ | P13-L |  | TB6-9 | ④ |
| X12P16N |  | 75.00 | BLK MKG | P13-M |  | TB6-12 | ④ |
| P55U16 |  | 74.00 | RED MKG | P13-T |  | GND STUD | ⑤ |
| D10A16 | ↓ | 53.50 | RED MKG | P13-R | ↓ | TB16-15 | ③ |
| D11A16 | 16 | 53.00 | RED MKG | P13-S | SOLDER | TB16-16 | ③ |

| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 8 | 8 | PLUG, END SEAL, ELEC CONN |  |
| 7 | AR | STRAP, CABLE, ADJUSTABLE |  |
| 6 | AR | STRAP CABLE, ADJUSTABLE |  |
| 5 | 1 | TERMINAL, LUG, CRIMP STYLE |  |
| 4 | 2 | TERMINAL, LUG, CRIMP STYLE |  |
| 3 | 8 | TERMINAL, LUG, CRIMP STYLE |  |
| 2 | AR | WIRE AN 16, COLOR WHITE | MIL-W-5086/2 |
| 1 | 1 | CONNECTOR, PLUG, ELEC, STR |  |

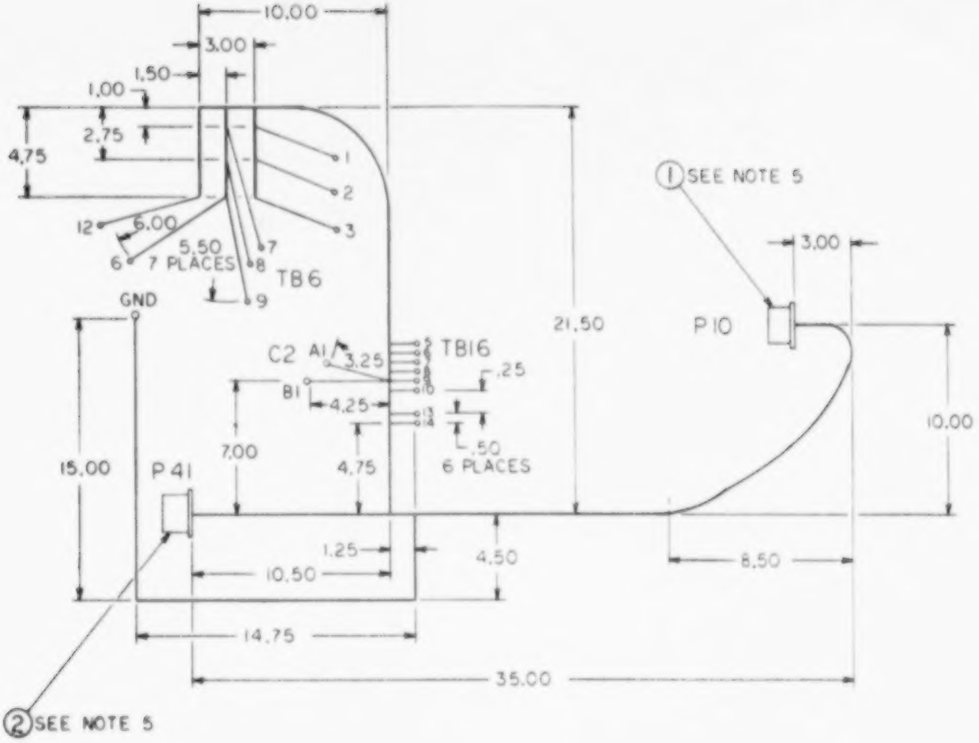
LIST OF MATERIAL

NOTES:

1 INTERPRET DRAWING PER MIL-STD-100
2 ALL WIRE ②* SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ⑥⑦. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT & AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3 SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4 WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5 INSTALL NYLON FILLER PLUGS ⑧ IN UNUSED OPENINGS OF CONNECTOR BUSHING.

ME 6115-545-34/5-1 C1

Figure 5-1. AC Power Control 50/60 Hz Wiring Harness


10.00
3.00
1.50
1.00
4.75
2.75
1
2
3
12
6.00
6
5.50
7 PLACES
7
8
TB6
9
GND
① SEE NOTE 5
3.00
P10
21.50
C2
A1
3.25
TB16
B1
.25
4.25
13
14
.50
6 PLACES
15.00
P41
7.00
4.75
10.00
1.25
10.50
4.50
8.50
14.75
35.00
② SEE NOTE 5

NOTES:

1 INTERPRET DRAWING PER MIL-STD-100

2 ALL WIRE ③④ SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ⑧⑨, LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.

3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454

4 WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.

5 INSTALL NYLON FILLER PLUGS ⑩⑪ IN UNUSED OPENINGS OF CONNECTOR BUSHING

| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 11 | 2 | PLUG END SEAL ELEC CONN | |
| 10 | 3 | PLUG END SEAL ELEC CONN | |
| 9 | AR | STRAP CABLE ADJUSTABLE | |
| 8 | AR | STRAP CABLE ADJUSTABLE | |
| 7 | 1 | TERMINAL LUG CRIMP STYLE | |
| 6 | 10 | TERMINAL LUG CRIMP STYLE | |
| 5 | 8 | TERMINAL LUG CRIMP STYLE | |
| 4 | AR | WIRE, AN-12 COLOR WHITE | MIL-W-5086/2 |
| 3 | AR | WIRE AN-16 COLOR WHITE | MIL-W-5086/2 |
| 2 | 1 | CONNECTOR PLUG ELEC STR | |
| 1 | 1 | CONNECTOR PLUG ELEC STR | |

LIST OF MATERIAL

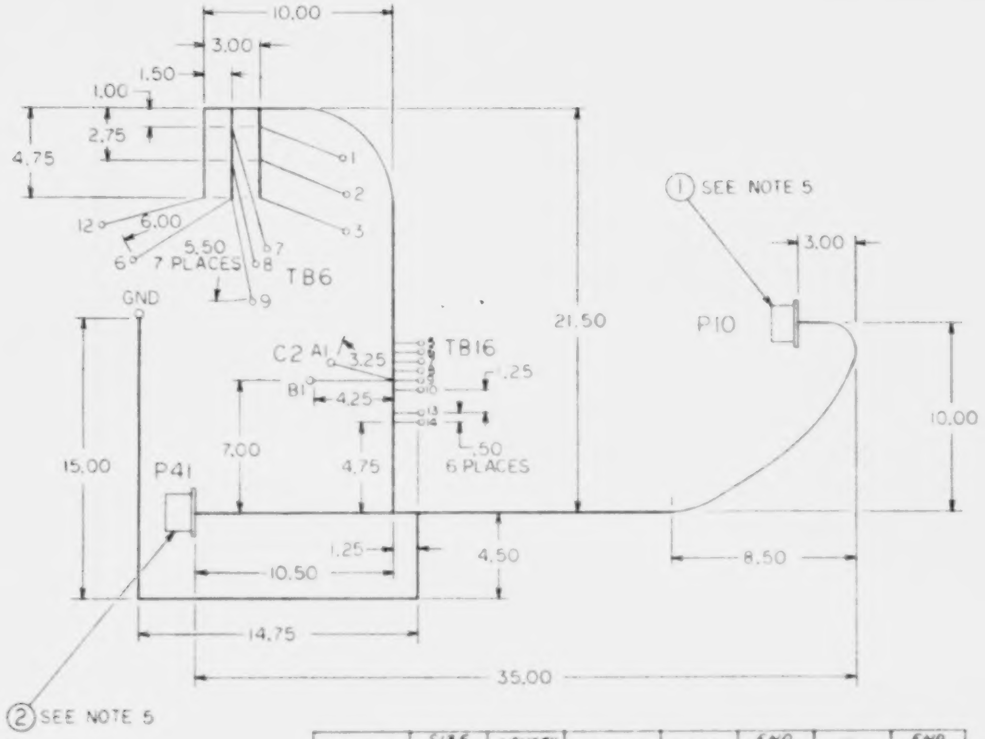
ME 6115-545-34/5-2(1) C1

Figure 5-2. AC Power Control 400 Hz, Wiring Harness (Sheet 1 of 2)

| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| D20D16 | 16 | 41.00 | BLK MKG | P10-A | SOLDER | TB16-9 | ⑤ |
| D21D16 | ↑ | 42.00 | ↑ | P10-B | ↑ | TB16-7 | ↑ |
| D22D16 | | 43.00 | | P10-C | | TB16-5 | ↓ |
| X17E16 | | 40.50 | | P10-D | | TB16-10 | ⑤ |
| X7E16A | | 72.00 | | P10-E | | TB6-7 | ⑥ |
| X8E16B | | 72.00 | | P10-F | | TB6-8 | ↑ |
| X14H16 | | 72.00 | | P10-G | | TB6-1 | |
| X15A16 | | 72.50 | | P10-H | | TB6-2 | ↓ |
| X16H16 | | 72.00 | | P10-L | | TB6-3 | ⑥ |
| X18E16 | | 41.50 | | P10-J | | TB16-8 | ⑤ |
| X19E16 | | 42.50 | | P10-K | | TB16-6 | ⑤ |
| X97B16 | ↓ | 47.00 | ↓ | P10-M | | P41-E | SOLDER |
| X98G16 | 16 | 47.00 | BLK MKG | P10-N | | P41-F | SOLDER |
| P55MN12N | 12 | 55.00 | RED MKG | P10-O | | GND STUD | ⑦ |
| P63B16 | 16 | 47.00 | RED MKG | P10-U | | P41-A | SOLDER |
| X195M16 | ↑ | 38.50 | BLK MKG | P10-V | | TB16-14 | ⑤ |
| X194F16 | | 39.00 | BLK MKG | P10-W | | TB16-13 | ⑤ |
| P55DY16 | | 47.00 | RED MKG | P10-Z | | P41-B | SOLDER |
| P50XX16 | | 47.00 | ↑ | P10-a | | P41-J | ↑ |
| P199D16 | | 47.00 | | P10-b | | P41-K | |
| P50Z16 | | 47.00 | ↓ | P10-c | | P41-D | ↓ |
| P56L16 | | 47.00 | RED MKG | P10-d | | P41-C | SOLDER |
| X96P16C | | 72.00 | BLK MKG | P10-e | | TB6-9 | ⑥ |
| X12ES16N | | 72.00 | ↑ | P10-f | | TB6-12 | ⑥ |
| X6A16 | | 72.00 | | P10-g | | TB6-6 | ⑥ |
| K112H16 | | 47.00 | | P10-J | | P41-G | SOLDER |
| K110E16 | | 47.00 | | P10-h | | P41 H | SOLDER |
| X21S16A | | 46.00 | | P10-X | | CB2-A1 | ⑥ |
| X22S16B | | 47.00 | | P10-Y | | CB2 B1 | ⑥ |
| P148B16 | | 47.00 | | P10-I | | P41-R | SOLDER |
| P149B16 | | 47.00 | | P10-K | | P41-T | ↑ |
| P150B16 | ↓ | 47.00 | ↓ | P10-R | ↓ | P41-N | ↓ |
| P151B16 | 16 | 47.00 | BLK MKG | P10-P | SOLDER | P41-P | SOLDER |

ME 6115-545-34/5-2(2)

Figure 5-2. AC Power Control 400 Hz, Wiring Harness (Sheet 2 of 2)



NOTES:

1 INTERPRET DRAWING PER MIL-STD-100.

2 ALL WIRE ③④ SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ⑧⑨, LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.

3 SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.

4 WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.

5 INSTALL NYLON FILLER PLUGS⑩⑪ IN UNUSED OPENINGS OF CONNECTOR BUSHING.

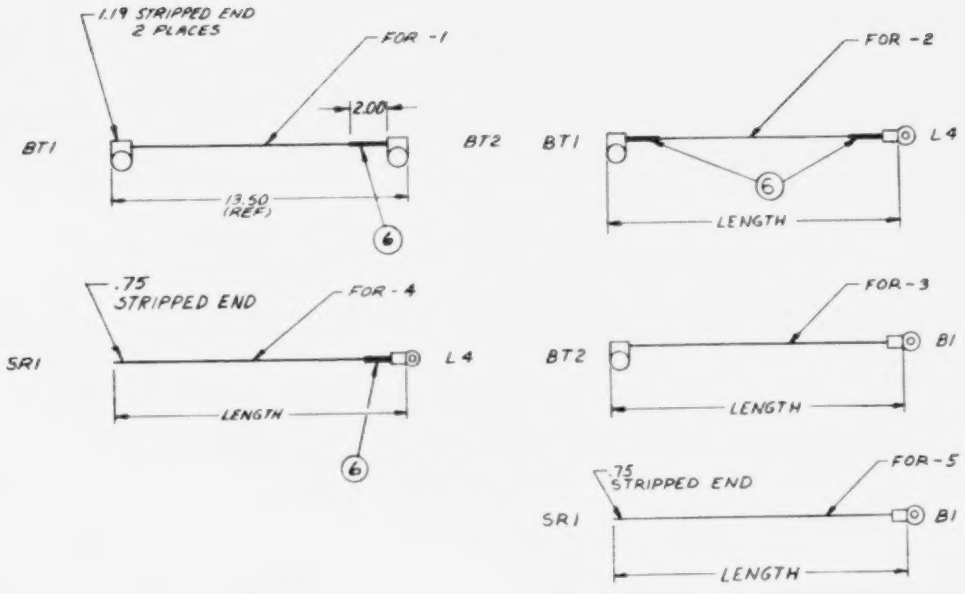
| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| D20D16 | 16 | 40.50 | BLK MKG | P10-A | SOLDER | TB16-9 | ⑤ |
| D21D16 | ↑ | 42.00 | ↑ | P10-B | ↑ | TB16-7 | ↑ |
| D28D16 | | 43.00 | | P10-C | | TB16-5 | ↓ |
| X17E16 | | 41.00 | | P10-D | | TB16-10 | ⑤ |
| X7E16A | | 62.50 | | P10-E | | TB6-7 | ⑥ |
| X8E16B | | 64.50 | | P10-F | | TB6-8 | ↑ |
| X14H16 | | 61.50 | | P10-G | | TB6-1 | |
| X15A16 | | 63.50 | | P10-H | | TB6-2 | ↓ |
| X16H16 | | 65.50 | | P10-L | | TB6-3 | ⑥ |
| X18E16 | | 42.50 | | P10-J | | TB16-8 | ⑤ |
| X19E16 | | 43.50 | | P10-K | | TB16-6 | ⑤ |
| X97B16 | ↓ | 44.50 | ↓ | P10-M | | P41-E | SOLDER |
| X98G16 | 16 | 44.50 | BLK MKG | P10-N | | P41-F | SOLDER |
| P55MN12N | 12 | 61.00 | RED MKG | P10-O | | GND STUD | ⑦ |
| P63B16 | 16 | 44.50 | RED MKG | P10-U | | P41-A | SOLDER |
| X195M16 | ↑ | 39.25 | BLK MKG | P10-V | | TB16-14 | ⑤ |
| X194F16 | | 39.75 | BLK MKG | P10-W | | TB16-13 | ⑤ |
| P55DY16 | | 44.50 | RED MKG | P10-Z | | P41-B | SOLDER |
| P50XX16 | | 44.50 | ↑ | P10-a | | P41-J | ↑ |
| P199D16 | | 44.50 | | P10-b | | P41-K | |
| P50Z16 | | 44.50 | ↓ | P10-c | | P41-D | ↓ |
| P56L16 | | 44.50 | RED MKG | P10-d | | P41-C | SOLDER |
| X96P16C | | 66.50 | BLK MKG | P10-e | | TB6-9 | ⑥ |
| X12E616N | | 68.50 | ↑ | P10-f | | TB6-12 | ⑥ |
| X6A16 | | 67.00 | | P10-g | | TB6-6 | ⑥ |
| K112N16 | | 44.50 | | P10-j | | P41-G | SOLDER |
| K110E16 | | 44.50 | | P10-h | | P41-H | SOLDER |
| X21S16A | ↓ | 43.50 | ↓ | P10-X | ↓ | CB2-A1 | ⑥ |
| X22S16B | 16 | 44.25 | BLK MKG | P10-Y | SOLDER | CB2-B1 | ⑥ |

| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 11 | 4 | PLUG, END SEAL, ELEC CONN | |
| 10 | 9 | PLUG, END SEAL, ELEC CONN | |
| 9 | AR | STRAP, CABLE, ADJUSTABLE | |
| 8 | AR | STRAP, CABLE, ADJUSTABLE | |
| 7 | 1 | TERMINAL, LUG, CRIMP STYLE | |
| 6 | 10 | TERMINAL, LUG, CRIMP STYLE | |
| 5 | 8 | TERMINAL, LUG, CRIMP STYLE | |
| 4 | AR | WIRE, AN-12 COLOR WHITE | MIL-W-5086/2 |
| 3 | AR | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| 2 | 1 | CONNECTOR, PLUG, ELEC, STR | |
| 1 | 1 | CONNECTOR, PLUG, ELEC, STR | |

LIST OF MATERIAL

ME 6115-545-34/5-3 C1

Figure 5-3. AC Power Control 50/60 Hz, Wiring Harness


1.19 STRIPPED END
2 PLACES
FOR -1
2.00
BT1
BT2
13.50
(REF)
6
FOR -2
BT1
L4
6
LENGTH
.75
STRIPPED END
FOR - 4
SR1
L4
LENGTH
6
FOR - 3
BT2
B1
LENGTH
.75
STRIPPED END
FOR - 5
SR1
B1
LENGTH

NOTES :

1. INTERPRET DRAWING PER MIL-STD-100.
2. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
3. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.

ME 6115-545-34/5-4(1) C1

Figure 5-4. DC Power Cables Wiring Harness (Sheet 1 of 2)

| DASH NO | WIRE NO. | SIZE REF | LENGTH | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|---|
| -1 | P140FO | 1/0 | 13.50 | RED MKG | BT1-(-) | ② | BT2-(+) | ① |
| -2 | P140EO | 1/0 | 50.00 | RED MKG | BT1-(+) | ① | L4-(+) | ③ |
| -3 | P55DCON | 1/0 | 54.00 | RED MKG | BT2-(-) | ② | B1-(-) | ③ |
| -4 | P140JO | 1/0 | 59.50 | RED MKG | SR1-(+) | SOLDER | L4-(+) | ③ |
| -5 | P55DUON | 1/0 | 53.75 | RED MKG | SR1-(-) | SOLDER | B1-(-) | ③ |

| FIND NO. | SYM | CODE IDENT | DWG SIZE | PART OR IDENTIFYING NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
|---|---|---|---|---|---|---|---|---|
| 6 | B | | | | 1 | INSUL, SLEEVING, .75 ID, RED | MIL-I-23053/5 | |
| | | | | M13486/1-14 | AR | CABLE, 1/0, COLOR BLACK | MIL-C-13486/1 | |
| 4 | B | | | MS25036-134 | 2 | TERMINAL, LUG, CRIMP STYLE | MIL-T-7928 | |
| 3 | | | | | | | | |
| 2 | C | | B | 70-1581-2 | 1 | CLAMP, TERM, BATTERY | | |
| 1 | C | | B | 70-1581-1 | 1 | CLAMP, TERM, BATTERY | | |

LIST OF MATERIAL

ME 6115-545-34/5-4(2) C1

Figure 5-4. DC Power Cables Wiring Harness (Sheet 2 of 2)

(DELETED)

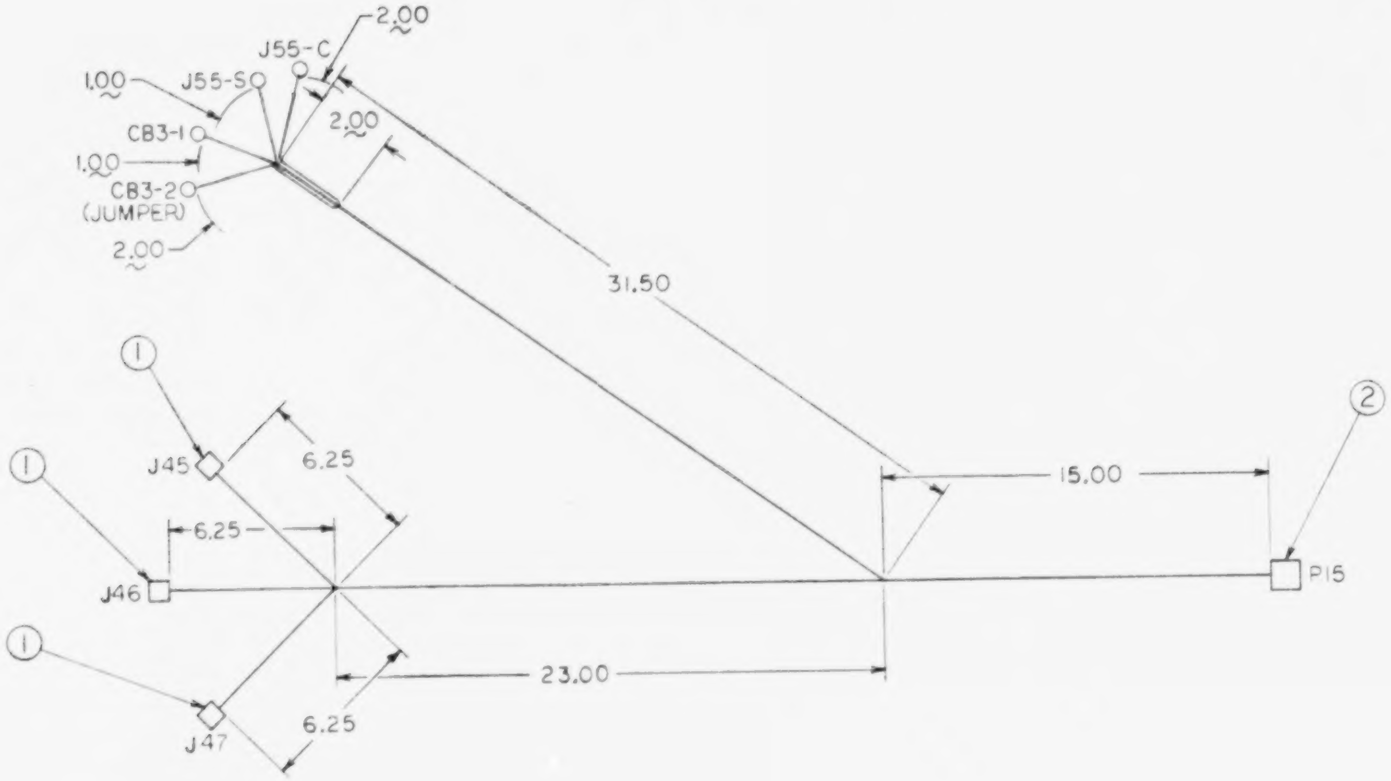
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 7 | AR | STRAP, CABLE, ADJUSTABLE | |
| 6 | AR | INSUL. SLEEVING, .125 I.D., BLK | MIL-I-23053/5, CLASS I |
| 5 | AR | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| 4 | 3 | PLUG, END, SEAL, ELEC CONN | |
| 3 | 4 | TERMINAL, LUG, CRIMP STYLE | |
| 2 | 1 | CONNECTOR, PLUG, ELEC, STR | |
| 1 | 3 | CONNECTOR, RECPT, ELEC, STR | |

LIST OF MATERIAL

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X96AA16 | 16 | 44.25 | BLK MKG | P15-A | SOLDER | J45-D | SOLDER |
| X96BB16 | ↑ | ↑ | ↑ | P15-E | ↑ | J46-D | ↑ |
| X96CC16 | | | | P15-J | | J47-D | |
| X98AA16 | | | | P15-B | | J45-C | |
| X98BB16 | | | | P15-F | | J46-C | |
| X98CC16 | | | | P15-K | | J47-C | |
| K111AA16 | | | | P15-C | | J45-B | |
| K111BB16 | | | | P15-G | | J46-B | |
| K111CC16 | | | | P15-L | | J47-B | |
| K112AA16 | | | | P15-D | | J45-A | |
| K112BB16 | | ↓ | | P15-H | | J46-A | ↓ |
| K112CC16 | | 44.25 | | P15-M | | J47-A | SOLDER |
| X12GG16N | | 47.50 | | P15-P | ↓ | J55-S | ③ |
| X9GG16C | ↓ | 47.50 | ↓ | P15-S | SOLDER | CB3-1 | " |
| X100A16 | 16 | 8.00 | BLK MKG | CB3-2 | ③ | J55-C | " |

ME 6115-545-34/5-6(1)

, Figure 5-6. Convenience and Paralleling, Wiring Harness (Sheet 1 of 2)


2.00
J55-C
1.00
J55-S
CB3-1
1.00
CB3-2
(JUMPER)
2.00
2.00
31.50
①
①
①
②
J45
6.25
6.25
J46
15.00
P15
23.00
6.25
J47

NOTES:

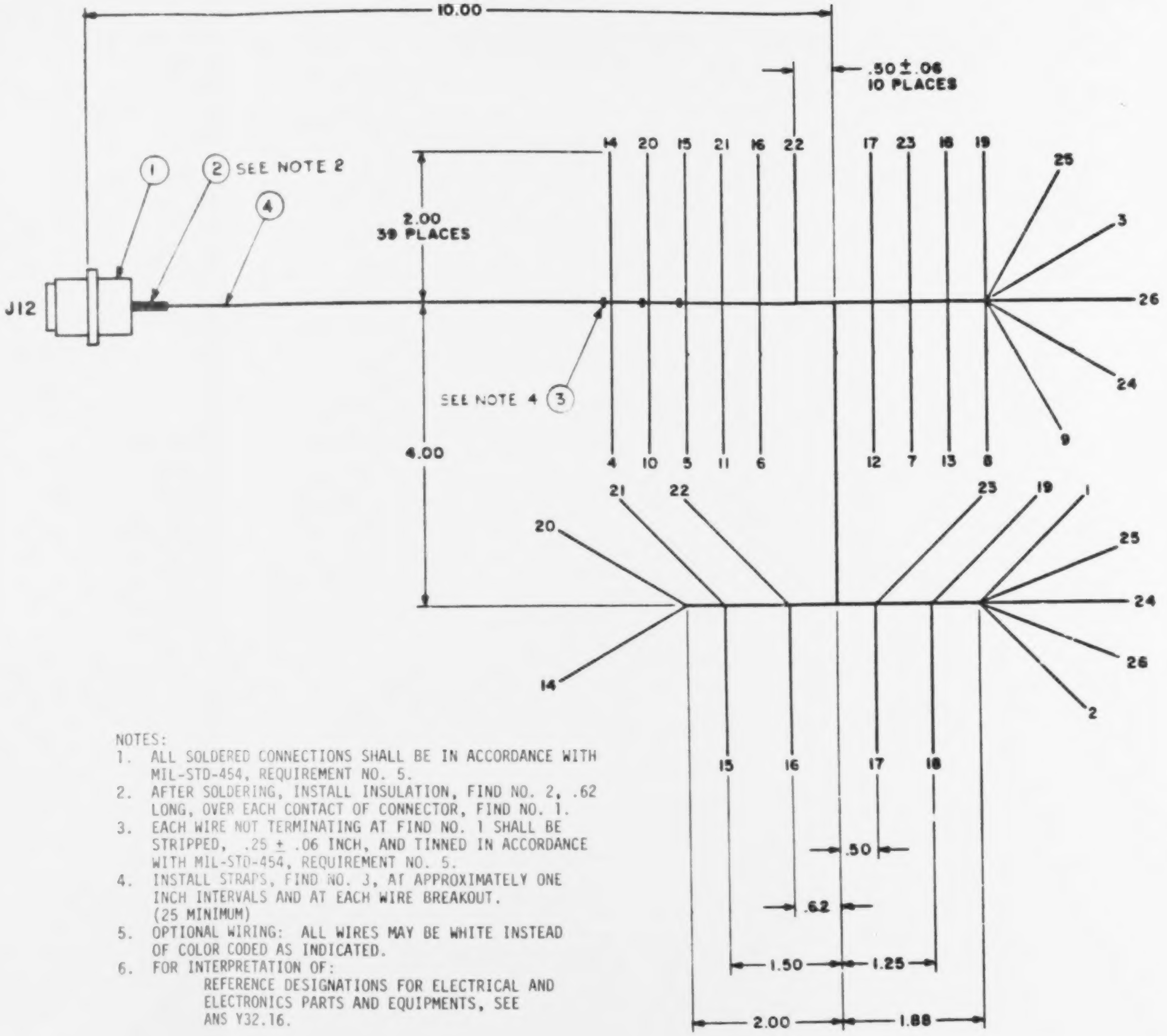
1. INTERPRET DRAWING PER MIL-STD-100.
2. ALL WIRE SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING NYLON STRAPS. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. CUT INSULATION TUBING IN HALF-INCH PIECES AND INSTALL AROUND WIRES AND PINS AND RECEPTACLES.

ME 6115-545-34/5-6(2)

Figure 5-6. Convenience and Paralleling, Wiring Harness (Sheet 2 of 2)

| WIRE NO. | TERMINATION<br>FROM | <br>FIND NO. | TERMINATION<br>TO | <br>FIND NO. |  | WIRE FIND NO. | COLOR IDENT SEE NOTE 5 |
|---|---|---|---|---|---|---|---|
| 1 | J12-A | 1 | XF1 | — |  | 4 | RED-WHT |
| 2 | J12-B | 1 | S1-2 | — |  | 4 | GRN-WHT |
| 3 | J12-C | 1 | XK1-1 | — |  | 4 | WHT-ORN |
| 4 | J12-D | 1 | TB1-1 | — |  | 4 | BLK-WHT |
| 5 | J12-E | 1 | TB1-3 | — |  | 4 | WHT-VIO |
| 6 | J12-F | 1 | TB1-5 | — |  | 4 | WHT-GRN |
| 7 | J12-G | 1 | TB1-7 | — |  | 4 | ORN-WHT |
| 8 | J12-H | 1 | TB1-9 | — |  | 4 | WHT-BRN |
| 9 | J12-J | 1 | TB1-10 | — |  | 4 | WHT-BLK |
| 10 | J12-K | 1 | TB1-2 | — |  | 4 | WHT-GRA |
| 11 | J12-L | 1 | TB1-4 | — |  | 4 | WHT-BLU |
| 12 | J12-M | 1 | TB1-6 | — |  | 4 | WHT-YEL |
| 13 | J12-N | 1 | TB1-8 | — |  | 4 | WHT-RED |
| 14 | XDS1 | — | TB1-21 | — |  | 4 | WHT |
| 15 | XDS2 | — | TB1-25 | — |  | 4 | VIO |
| 16 | XDS3 | — | TB1-29 | — |  | 4 | GRN |
| 17 | XDS4 | — | TB1-33 | — |  | 4 | ORN |
| 18 | XDS5 | — | TB1-37 | — |  | 4 | BRN |
| 19 | XDS6 | — | TB1-39 | — |  | 4 | BLK |
| 20 | XDS7 | — | TB1-23 | — |  | 4 | GRA |
| 21 | XDS8 | — | TB1-27 | — |  | 4 | BLU |
| 22 | XDS9 | — | TB1-31 | — |  | 4 | YEL |
| 23 | XDS10 | — | TB1-35 | — |  | 4 | RED |
| 24 | S1-5 | — | XK1-3 | — |  | 4 | WHT-BLU |
| 25 | S1-3 | — | TB1-40 | — |  | 4 | ORN-GRA |
| 26 | S1-4 | — | TB1-50 | — |  | 4 | WHT-VIO |

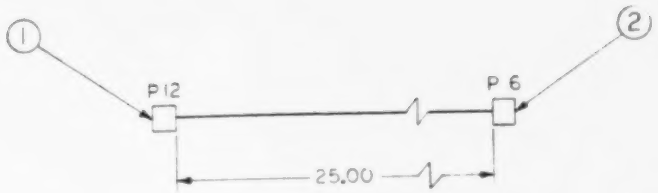
|  |  |  |  |
|---|---|---|---|
| 4 | AR | WIRE, ELEC, INSULATED, HIGH TEMP, 600 V | MIL-W-16878/4 |
|  |  | NO. 22 AWG SIZE |  |
| 3 | AR | STRAP, CABLE, ADJUSTABLE |  |
| 2 | AR | INSULATION, ELECTRICAL | MIL-I-631 |
|  |  |  |  |
|  |  |  |  |
| 1 | 1 | CONNECTOR RECEPTACLE |  |
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIAL |  |  |  |



NOTES:
1. ALL SOLDERED CONNECTIONS SHALL BE IN ACCORDANCE WITH MIL-STD-454, REQUIREMENT NO. 5.
2. AFTER SOLDERING, INSTALL INSULATION, FIND NO. 2, .62 LONG, OVER EACH CONTACT OF CONNECTOR, FIND NO. 1.
3. EACH WIRE NOT TERMINATING AT FIND NO. 1 SHALL BE STRIPPED, .25 ± .06 INCH, AND TINNED IN ACCORDANCE WITH MIL-STD-454, REQUIREMENT NO. 5.
4. INSTALL STRAPS, FIND NO. 3, AT APPROXIMATELY ONE INCH INTERVALS AND AT EACH WIRE BREAKOUT. (25 MINIMUM)
5. OPTIONAL WIRING: ALL WIRES MAY BE WHITE INSTEAD OF COLOR CODED AS INDICATED.
6. FOR INTERPRETATION OF:
   REFERENCE DESIGNATIONS FOR ELECTRICAL AND ELECTRONICS PARTS AND EQUIPMENTS, SEE ANS Y32.16.

ME 6115-545-34/5-7

Figure 5-7. Fault Indicator Panel,
Wiring Harness



| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| P210A16 | 16 | 25.00 | RED MKG | P6-N | SOLDER | P12-N | SOLDER |
| P209A16 | ↑ | ↑ | ↑ | P6-M | ↑ | P12-M | ↑ |
| P208A16 |  |  |  | P6-L |  | P12-L |  |
| P207A16 |  |  |  | P6-K |  | P12-K |  |
| P206A16 |  |  |  | P6-I |  | P12-I |  |
| P205A16 |  |  |  | P6-H |  | P12-H |  |
| P204A16 |  |  |  | P6-G |  | P12-G |  |
| P203A16 |  |  |  | P6-F |  | P12-F |  |
| P202A16 |  |  |  | P6-E |  | P12-E |  |
| P201A16 |  |  |  | P6-D |  | P12-D |  |
| P200A16 |  |  |  | P6-C |  | P12-C |  |
| P66B16N | ↓ | ↓ | ↓ | P6-B | ↓ | P12-B | ↓ |
| P45K16 | 16 | 25.00 | RED MKG | P6-A | SOLDER | P12-A | SOLDER |

| | | | |
|---|---|---|---|
| 5 | AR | STRAP, CABLE, ADJUSTABLE |  |
| 4 | 2 | PLUG, END SEAL, ELEC CONN |  |
| 3 | AR | WIRE, AN 16, COLOR WHITE | MIL-W-5086 |
| 2 | 1 | CONNECTOR, PLUG, ELEC STR |  |
| 1 | 1 | CONNECTOR, PLUG, ELEC STR |  |
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIAL | | | |

NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. WIRING SHALL BE NEATLY LACED THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ⑤, LOCATED AT INTERVALS NOT TO EXCEED THREE INCHES BETWEEN STRAPS.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRING NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. INSTALL NYLON FILLER PLUGS ④ IN UNUSED OPENINGS OF CONNECTOR BUSHING.

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Figure 5-8. Fault Indicator Panel, Interconnecting Wiring Harness

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| D20A16 | 16 | 25.00 | BLK MKG | P1-A | SOLDER | P2-A | SOLDER |
| D21A16 | ↑ | ↑ | ↑ | P1-B | ↑ | P2-B | ↑ |
| D22A16 |  |  |  | P1-C |  | P2-C |  |
| D24D16 |  |  |  | P1-D |  | P2-D |  |
| X7B16A |  |  |  | P1-E |  | P2-E |  |
| X8C16B |  |  |  | P1-F |  | P2-F |  |
| X14G16 |  |  |  | P1-G |  | P2-G |  |
| X15G16 |  |  |  | P1-H |  | P2-H |  |
| X16E16 |  |  |  | P1-I |  | P2-I |  |
| L25B16 |  |  |  | P1-J |  | P2-J |  |
| L26B16 |  |  |  | P1-K |  | P2-K |  |
| X91B16 |  |  |  | P1-L |  | P2-L |  |
| K32B16 |  |  |  | P1-M |  | P2-M |  |
| K33B16 |  |  |  | P1-N |  | P2-N |  |
| X31B16 |  |  | ↓ | P1-O |  | P2-O |  |
| X194B16 |  |  | BLK MKG | P1-P |  | P2-P |  |
| P45F16 |  |  | RED MKG | P1-R |  | P2-R |  |
| X29B16 |  |  | BLK MKG | P1-S |  | P2-S |  |
| K34B16 |  |  | BLK MKG | P1-T |  | P2-T |  |
| X90C16 |  |  | BLK MKG | P1-U |  | P2-U |  |
| E39B16 |  |  | RED MKG | P1-V |  | P2-V |  |
| E38B16 |  |  | ↑ | P1-W |  | P2-W |  |
| E37B16 |  |  |  | P1-X |  | P2-X |  |
| E35B16 |  |  |  | P1-Y |  | P2-Y |  |
| E36B16 |  |  | ↓ | P1-Z |  | P2-Z |  |
| P199B16 |  |  | RED MKG | P1-a |  | P2-a |  |
| L93C16 |  |  | BLK MKG | P1-b |  | P2-b |  |
| P198B16 |  |  | RED MKG | P1-c |  | P2-c |  |
| P47C16 |  |  | RED MKG | P1-e |  | P2-e |  |
| X195B16 |  |  | BLK MKG | P1-f |  | P2-f |  |
| P44C16 |  |  | RED MKG | P1-g |  | P2-g |  |
| P62C16 |  |  | RED MKG | P1-h |  | P2-h |  |
| P56B16 |  |  | RED MKG | P1-k |  | P2-k |  |
| P80D16 |  |  | RED MKG | P1-m |  | P2-m |  |
| X197B16 |  |  | BLK MKG | P1-n |  | P2-n |  |
| P55A16N |  |  | RED MKG | P1-p |  | P2-p |  |
| P57D16 |  |  | ↑ | P1-t |  | P2-t |  |
| P40M16 |  |  |  | P1-u |  | P2-u |  |
| P40L16 |  |  | ↓ | P1-v |  | P2-v |  |
| P55BC16N |  |  | RED MKG | P1-r |  | P2-r |  |
| X9B16C |  |  | BLK MKG | P1-z |  | P2-z |  |
| P50H16 |  |  | RED MKG | P1-w |  | P2-w |  |
| P46B16 | ↓ | ↓ | RED MKG | P1-x | ↓ | P2-x | ↓ |
| X12A16N | 16 | 25.00 | BLK MKG | P1-y | SOLDER | P2-y | SOLDER |

| | | | |
|---|---|---|---|
| 5 | AR | STRAP, CABLE, ADJUSTABLE |  |
| 4 | 6 | PLUG, END SEAL, ELEC CONN |  |
| 3 | AR | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| 2 | 1 | CONNECTOR, PLUG, ELEC, STR |  |
| 1 | 1 | CONNECTOR, PLUG, ELEC, STR |  |
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIAL | | | |

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Figure 5-9. Control Cubicle, Interconnecting Wiring Harness (Sheet 2 of 2)

| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 13 | 12 1/4 in. | INSULATION TUBING, ELECTRICAL, HEAT SHRINKABLE, BLACK 187 DIA | MIL-1-23853 |
| 12 | 1 | CONNECTOR, RECEPTACLE, ELECTRICAL | |
| 11 | | TERMINAL, LUG, CRIMP STYLE COPPER, INS., CLASS 1, NO. 8 STUD SIZE, NO. 16-14 W SIZE | |
| 10 | | TERMINAL, LUG, CRIMP STYLE, COPPER, INS., CLASS 1, 1/4 STUD SIZE, NO. 16-14 W SIZE | |
| 9 | | TERMINAL, LUG, CRIMP STYLE, COPPER, INS., CLASS 1, NO. 10 STUD SIZE, NO. 16-14 W SIZE | |
| 8 | | TERMINAL, LUG, CRIMP STYLE, COPPER, INS., CLASS 1, NO. 6 STUD SIZE, NO. 16-14 W SIZE | |
| 7 | | TERMINAL, LUG, CRIMP STYLE, COPPER, INS., CLASS 1, 1/4 STUD SIZE, NO. 22-18 W SIZE | |
| 6 | | TERMINAL, LUG, CRIMP STYLE, COPPER, INS., CLASS 1, NO. 10 STUD SIZE, NO. 22-18 W SIZE | |
| 5 | | TERMINAL, LUG, CRIMP STYLE, COPPER, INS., CLASS 1, NO. 8 STUD SIZE, NO. 22-18 W SIZE | |
| 4 | | TERMINAL, LUG, CRIMP STYLE, COPPER, INS., CLASS 1, NO. 6 STUD SIZE, NO. 22-18 W SIZE | |
| 3 | | STRAP, CABLE, ADJUSTABLE, SELF-CLINCHING, PLASTIC, TYPE 1, CLASS 1 | |
| 2 | AR | WIRE, ELECTRICAL, 600-VOLT, COPPER, AIRCRAFT, NO. AN-16 | MIL-W-5086/2 |
| 1 | AR | WIRE, ELECTRICAL, 600-VOLT, COPPER, AIRCRAFT, NO. AN-16 | MIL-W-5086/2 |

LIST OF MATERIAL

NOTES:

1. CONTACT PINS ARE SUPPLIED WITH CONNECTOR (ITEM 12) AND SHALL BE USED IN THEIR RESPECTIVE HOLES.
2. CUT INSULATION TUBING (ITEM 13) INTO 38 PIECES .375 LONG AND INSTALL AROUND WIRES AND PINS ATTACHED TO THE CONNECTOR (ITEM 12). THEN APPLY HEAT OF 400° F FOR 3-5 SEC. FOR PROPER SHRINKAGE.
3. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5086, PARA 3.9.3. & 3.9.3.1 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
4. FOR INTERPRETATION OF:
   4.1 ELECTRICAL REFERENCE DESIGNATIONS, SEE ASA Y32.16

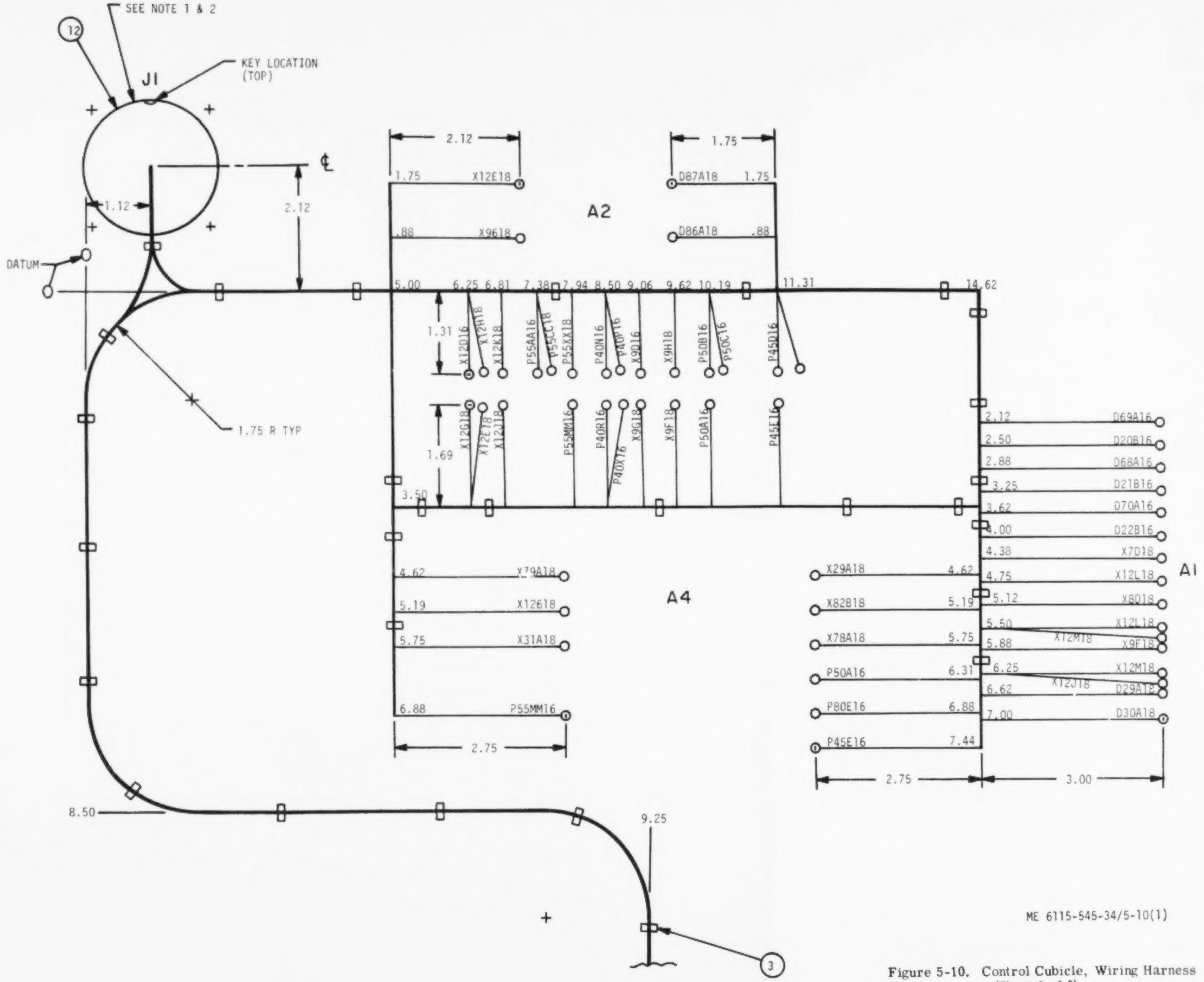
12
SEE NOTE 1 & 2
KEY LOCATION
(TOP)
J1
¢
DATUM
1.12
2.12
1.75 R TYP
2.12
1.75
X12E18
.88
X9G18
A2
1.75
D87A18
1.75
D86A18
.88
5.00
6.25
6.81
7.38
7.94
8.50
9.06
9.62
10.19
11.31
14.62
1.31
X12D16
X12H18
X12K18
P55AA16
P55CC18
P55XX18
P40N16
P40P16
X9D16
X9H18
P50B16
P50C16
P45D16
1.69
X12G18
X12E18
X12J18
P55MM16
P40R16
P40X16
X9G18
X9F18
P50A16
P45E16
3.50
4.62
X79A18
5.19
X12G18
5.75
X31A18
6.88
P55MM16
2.75
A4
X29A18
4.62
X82B18
5.19
X78A18
5.75
P50A16
6.31
P80E16
6.88
P45E16
7.44
2.75
2.12
D69A16
2.50
D20B16
2.88
D68A16
3.25
D21B16
3.62
D70A16
4.00
D22B16
4.38
X7D18
4.75
X12L18
5.12
X8D18
5.50
X12L18
X12M18
5.88
X9F18
6.25
X12M18
X12J18
6.62
D29A18
7.00
D30A18
3.00
A1
8.50
9.25
3
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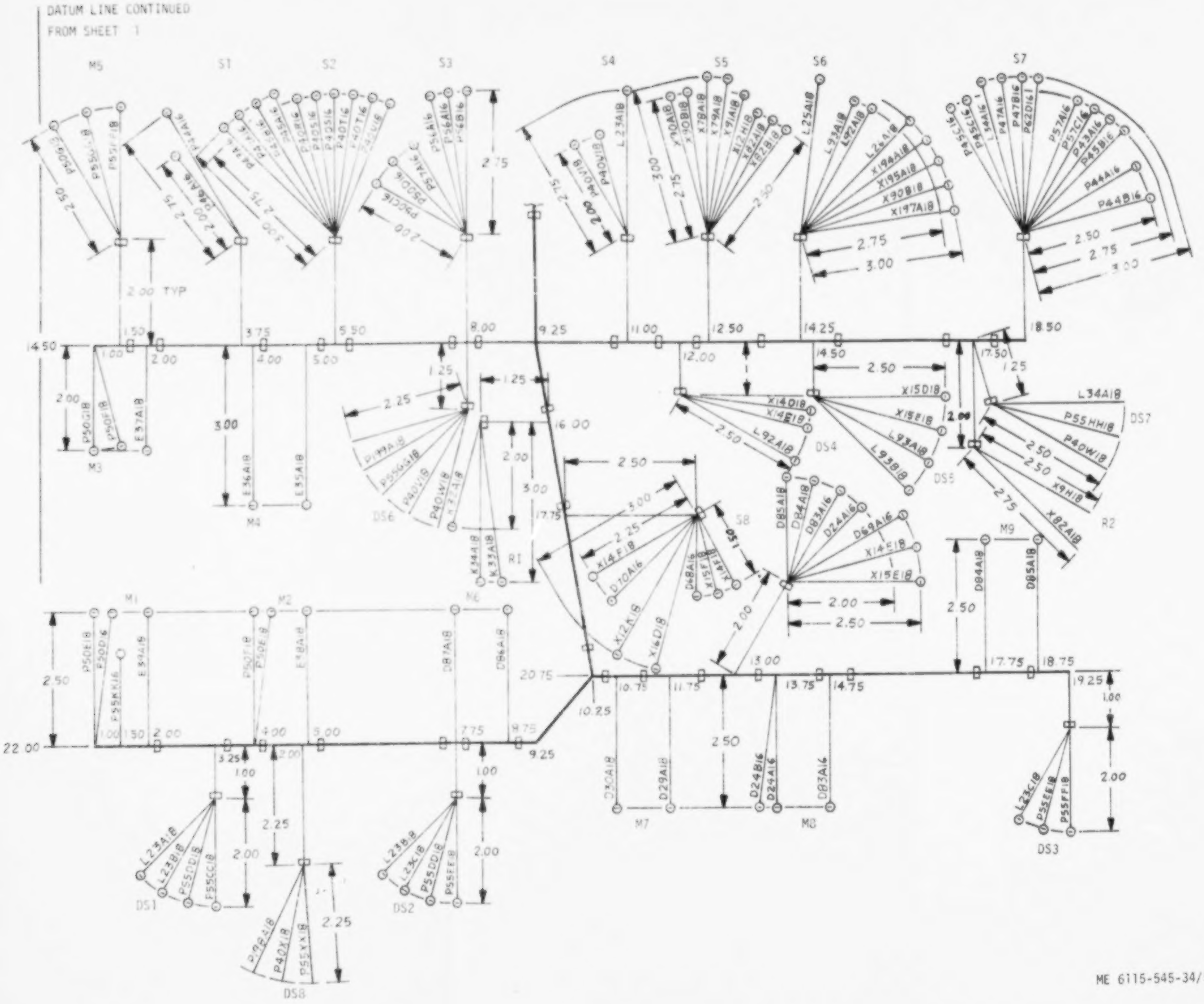
Figure 5-10. Control Cubicle, Wiring Harness (Sheet 1 of 3)



DATUM LINE CONTINUED
FROM SHEET 1
M5
S1
S2
S3
S4
S5
S6
S7
M3
M4
DS6
R1
S8
DS4
DS5
DS7
R2
M9
M1
M2
M6
M7
M8
DS1
DS2
DS3
DS8
2.00 TYP
14.50
22.00
L34A18
P55HH18
P40W18
X9H18
X82A18
X151D18
X15E18
L93A18
L93B18
X140D18
X14E18
L92A18
D85A18
D84A18
D83A16
D24A16
D69A16
X145E18
X15E18
X14F18
D70A16
X12K18
X16D18
D68A16
D84A18
D85A18
P50G18
P50F18
E37A18
E36A18
E35A18
K34A18
K33A18
P50E18
P50D16
P55KK16
E34A18
P50F18
P50E18
E38A18
D87A18
D86A18
D30A18
D29A18
D24B16
D24A16
D83A16
L23C18
P55EE18
P55FF18
L23A18
L23B18
P55DD18
P55CC18
L23B18
L23C18
P55DD18
P55EE18
P18A18
P40X18
P55X18
L23A18
L25A18
P44A16
P44B16

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Figure 5-10. Control Cubicle, Wiring Harness
(Sheet 2 of 3)

| WIRE MARKING NO. | FROM |  | TO |  | WIRE FIND NO. | CUT LENGTH IN. | MARKING COLOR |
|---|---|---|---|---|---|---|---|
|  | STATION NO. | LUG FIND NO. | STATION NO. | LUG FIND NO. |  |  |  |
| D20B16 | J1-A | - | A1-L1 | 8 | 1 | 21.5 | BLACK |
| D21B16 | J1-B | - | A1-L2 | 8 | 1 | 22 |  |
| D22B16 | J1-C | - | A1-L3 | 8 | 1 | 22.5 |  |
| D24A16 | M8-(-) | 10 | S8-41 | 8 | 1 | 6 |  |
| D24B16 | J1-D | - | M8-(-) | 10 | 1 | 38 |  |
| D29A18 | A1-(+) | 4 | M7-(+) | 7 | 2 | 53.5 |  |
| D30A18 | A1-(-) | 4 | M7-(-) | 7 | 2 | 52.5 |  |
| D68A16 | A1-S2 | 8 | S8-33 | 8 | 1 | 48.5 |  |
| D69A16 | A1-S1 | 8 | S8-32 | 8 | 1 | 54 |  |
| D70A16 | A1-S3 | 8 | S8-34 | 8 | 1 | 48.5 |  |
| D83A16 | S8-31 | 8 | M8-(+) | 10 | 1 | 7 |  |
| D84A18 | S8-11 | 4 | M9-(-) | 7 | 2 | 10 |  |
| D85A18 | S8-21 | 4 | M9-(+) | 7 | 2 | 11 |  |
| D85A18 | A2-(+) | 4 | M6-(+) | 7 | 2 | 44.5 |  |
| D87A18 | A2-(-) | 4 | M6-(-) | 7 | 2 | 47.5 |  |
| E35A18 | J1-Y | - | M4-(+) | 7 | 2 | 32 | RED |
| E36A18 | J1-Z | - | M4-(-) | 7 | 2 | 33 |  |
| E37A18 | J1-X | - | M3-(-) | 6 | 2 | 34 |  |
| E38A18 | J1-W | - | M2-(-) | 6 | 2 | 39 |  |
| E39A1G | J1-V | - | M1-(-) | 6 | 2 | 42 |  |
| K32A18 | J1-M | - | R1-M | 5 | 2 | 29.5 | BLACK |
| K33A18 | J1-N | - | R1-R | 5 | 2 | 30 | BLACK |
| K34A18 | J1-T | - | R1-L | 5 | 2 | 31 | BLACK |
| L23A18 | DS1-2 | 4 | S4-2 | 4 | 2 | 22.5 | RED |
| L23B18 | DS1-2 | 4 | DS2-2 | 4 | 2 | 10 | RED |
| L23C18 | DS2-2 | 4 | DS3-2 | 4 | 2 | 17 | RED |
| L25A18 | J1-J | - | S6-3 | 4 | 2 | 34.5 | BLACK |
| L26A18 | J1-K | - | S6-6 | 4 | 2 | 33.5 | BLACK |
| L34A18 | S7-12 | 4 | DS7-2 | 1/4 STRIP | 2 | 10 | RED |
| L92A18 | S6-2 | 4 | DS4-2 | 4 | 2 | 10 | BLACK |
| L93A18 | S6-5 | 4 | DS5-2 | 4 | 2 | 8 | BLACK |
| L93B18 | J1-b |  | DS5-2 | 4 | 2 | 32.5 | BLACK |
| P40N16 | J1-v | - | TB1-5 | 11 | 1 | 12 | RED |
| P40P16 | J1-u | - | TB1-5 | 11 | 1 | 11 |  |
| P40R16 | TB1-5 | 11 | S2-11 | 8 | 1 | 42.5 |  |
| P40S16 | S2-2 | 8 | S2-11 | 8 | 1 | 7 |  |
| P40T16 | S2-5 | 8 | S2-2 | 8 | 1 | 6 |  |
| P40U18 | S2-5 | 4 | S4-1 | 4 | 2 | 14 |  |
| P40V18 | S4-1 | 4 | DS6-3 | 1/4 STRIP | 2 | 10 |  |
| P40W18 | DS7-3 | 1/4 STRIP | DS6-3 | 1/4 STRIP | 2 | 16.5 |  |
| P40X18 | TB1-5 | 11 | DS8-3 | 1/4 STRIP | 2 | 52 |  |

| WIRE MARKING NO. | FROM |  | TO |  | WIRE FIND NO. | CUT LENGTH IN. | MARKING COLOR |
|---|---|---|---|---|---|---|---|
|  | STATION NO. | LUG FIND NO. | STATION NO. | LUG FIND NO. |  |  |  |
| P43A16 | S7-5 | 8 | S2-12 | 8 | 1 | 22 | RED |
| P44A16 | S1-1 | 8 | S7-4 | 8 | 1 | 23 |  |
| P44B16 | J1-g | - | S7-4 | 8 | 1 | 37 |  |
| P45A16 | TB1-10 | 11 | S2-3 | 8 | 1 | 45 |  |
| P45B16 | S2-3 | 8 | S7-8 | 8 | 1 | 22 |  |
| P45C16 | S7-8 | 8 | S7-11 | 8 | 1 | 7 |  |
| P45D16 | J1-R | - | TB1-10 | 11 | 1 | 14.5 |  |
| P45E16 | TB1-10 | 11 | A4-7 | 11 | 1 | 11 |  |
| P46A16 | J1-x | - | S1-2 | 8 | 1 | 34 |  |
| P47A16 | S2-6 | 8 | S7-9 | 8 | 1 | 22.5 |  |
| P47B16 | J1-[illegible] | - | S7-9 | 8 | 1 | 38 |  |
| P50A16 | TB1-8 | 11 | A4-9 | 11 | 1 | 12 |  |
| P50B16 | J1-w | - | TB1-8 | 11 | 1 | 13 |  |
| P50C16 | TB1-8 | 11 | S3-2 | 8 | 1 | 38 |  |
| P50D16 | M1-(+) | 9 | S3-2 | 8 | 1 | 23 |  |
| P50E18 | M1-(+) | 6 | M2-(+) | 6 | 2 | 7 |  |
| P50F18 | M3-(+) | 6 | M2-(+) | 5 | 2 | 25 |  |
| P50G18 | M5-(+) | 4 | M3-(+) | 6 | 2 | 6.5 |  |
| P55AA16 | J1-r | - | TB1-3 | 11 | 1 | 10 |  |
| P55CC18 | TB1-3 | 5 | DS1-1 | 4 | 2 | 47 |  |
| P55DD18 | DS1-1 | 4 | DS2-1 | 4 | 2 | 9.5 |  |
| P55EE18 | DS2-1 | 4 | DS3-1 | 4 | 2 | 17 |  |
| P55FF18 | M5-(-) | 4 | DS3-1 | 4 | 2 | 30 |  |
| P55GG18 | M5-(-) | 4 | DS6-1 | 1/4 STRIP | 2 | 14 |  |
| P55HH18 | DS6-1 | 1/4 STRIP | DS7-1 | 1/4 STRIP | 2 | 16.5 |  |
| F55KK16 | J1-p | - | M1-CASE | 9 | 1 | 42 |  |
| P55MM16 | A4-2 | 11 | TB1-4 | 11 | 1 | 10.5 |  |
| P55X18 | TB1-4 | 5 | DS8-1 | 1/4 STRIP | 2 | 50 |  |
| P56A16 | S3-3 | 8 | S3-6 | 8 | 1 | 7 |  |
| P56B16 | J1-k | - | S3-3 | 8 | 1 | 31 |  |
| P57A16 | S7-2 | 8 | S3-5 | 8 | 1 | 19 |  |
| P57C16 | J1-t |  | S7-2 | 8 | 1 | 38 |  |
| P62D16 | J1-n | - | S7-3 | 8 | 1 | 38.5 |  |
| P80E16 | J1-m | - | A4-8 | 11 | 1 | 25 |  |
| P199A18 | J1-a | - | DS6-2 | 1/4 STRIP | 2 | 32 |  |
| P198A18 | J1-c | - | DS8-2 | 1/4 STRIP | 2 | 40 |  |

| WIRE MARKING NO. | FROM |  | TO |  | WIRE FIND NO. | CUT LENGTH IN. | MARKING COLOR |
|---|---|---|---|---|---|---|---|
|  | STATION NO. | LUG FIND NO. | STATION NO. | LUG FIND NO. |  |  |  |
| X7D18 | J1-E | - | A1-V1 | 4 | 2 | 23.5 | BLACK |
| X8D18 | J1-F | - | A1-V2 | 4 | 2 | 23.5 |  |
| X9D16 | J1-z | - | TB1-6 | 11 | 1 | 12 |  |
| X9F18 | TB1-7 | 5 | A1-V3 | 4 | 2 | 12 |  |
| X9G18 | A2-2 | 4 | TB1-6 | 5 | 2 | 12.5 |  |
| X194A18 | J1-p | - | S6-11 | 4 | 2 | 36 |  |
| X195A18 | J1-f | - | S6-10 | 4 | 2 | 36 |  |
| X197A18 | J1-n | - | S6-8 | 4 | 2 | 36 |  |
| X9H18 | TB1-7 | 5 | R2-L | 1/4 STRIP | 2 | 43 | BLACK |
| X12D16 | J1-y | - | TB1-1 | 11 | 1 | 9 |  |
| X12E18 | A2-1 | 4 | TB1-1 | 5 | 2 | 10 |  |
| X12G18 | TB1-1 | 5 | A4-5 | 5 | 2 | 7.5 |  |
| X12H18 | TB1-1 | 5 | S5-4 | 4 | 2 | 36 |  |
| X12J18 | TB1-2 | 5 | A1-N3 | 4 | 2 | 15 |  |
| X12K18 | TB1-2 | 5 | S8-17 | 4 | 2 | 38 |  |
| X12L18 | A1-N1 | 4 | A1-N2 | 4 | 2 | 5.5 |  |
| X12M18 | A1-N2 | 4 | A1-N3 | 4 | 2 | 5.5 |  |
| X14D18 | J1-G | - | DS4-1 | 4 | 2 | 31 |  |
| X14E18 | S8-12 | 4 | DS4-1 | 4 | 2 | 18 |  |
| X14F18 | S8-12 | 4 | S8-24 | 4 | 2 | 4.5 |  |
| X15D18 | J1-H | - | DS5-1 | 4 | 2 | 33.5 |  |
| X15E18 | S8-22 | 4 | DS5-1 | 4 | 2 | 20 |  |
| X16D18 | J1-1 | - | S8-13 | 4 | 2 | 34 |  |
| X29A18 | J1-S | - | A4-12 | 5 | 2 | 23 |  |
| X31A18 | J1-0 | - | A4-4 | 5 | 2 | 14 |  |
| X78A18 | A4-10 | 5 | S5-3 | 4 | 2 | 51.5 |  |
| X79A18 | A4-6 | 5 | S5-6 | 4 | 2 | 40 |  |
| X82A18 | S5-1 | 4 | R2-M | 5/8 STRIP | 2 | 14 |  |
| X82B18 | A4-11 | 5 | S5-1 | 4 | 2 | 50 |  |
| X90A18 | J1-U | - | S5-2 | 4 | 2 | 32 |  |
| X90B18 | S6-7 | 4 | S5-2 | 4 | 2 | 11.5 |  |
| X91A18 | J1-L | - | S5-5 | 4 | 2 | 32.5 |  |

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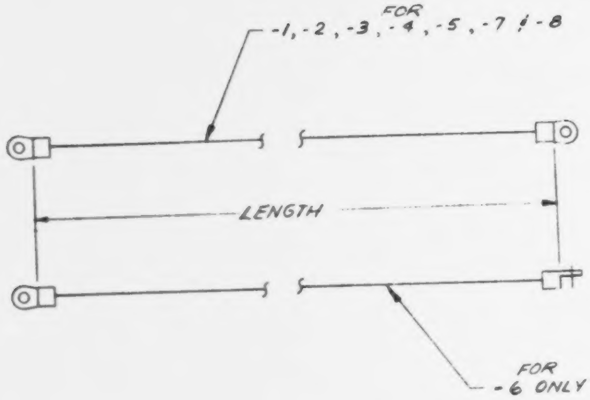
Figure 5-10. Control Cubicle, Wiring Harness
(Sheet 3 of 3)



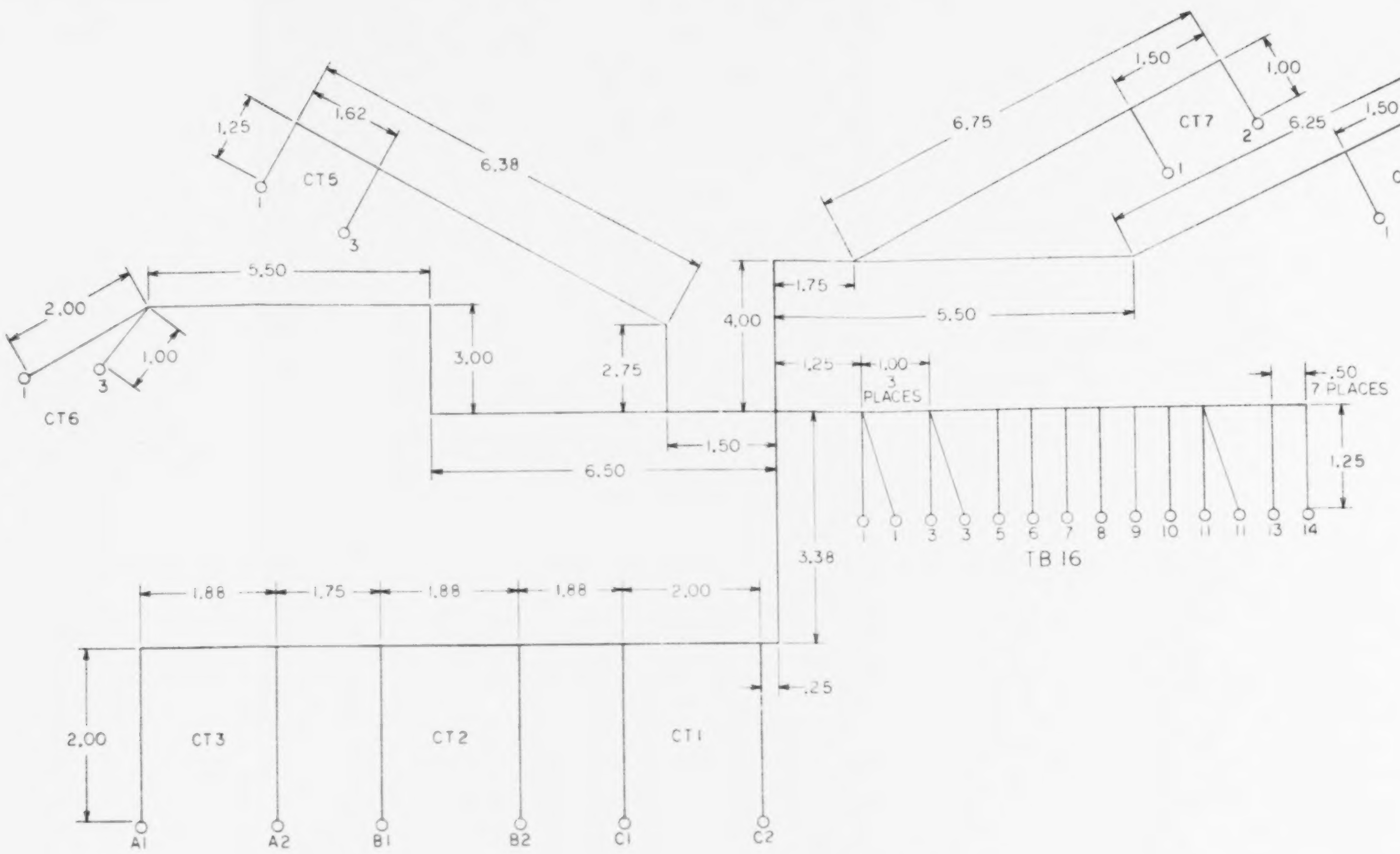
| DASH NO. | WIRE NO. | SIZE REF | LENGTH | COLOR | FROM | LUG | TO | LUG |
|---|---|---|---|---|---|---|---|---|
| -1 | X16A00C | 00 | 25.00 | BLK MKG | TB6-3 | ① | CB2-C2 | ① |
| -2 | X15J00B | ↑ | 24.00 | ↑ | TB6-2 | ↑ | CB2-B2 | ① |
| -3 | X14A00A |  | 22.00 |  | TB6-1 |  | CB2-A2 | ① |
| -4 | X21R00A |  | 11.00 |  | CB2-A1 |  | TB5-L1 | ④ |
| -5 | X22R00B | ↓ | 6.75 |  | CB2-B1 | ↓ | TB5-L2 | ④ |
| -6 | X23R00C | 00 | 11.50 |  | CB2-C1 | ① | TB5-L3 | ④ |
| -7 | X20E4N | 4 | 33.25 | ↓ | TB6-13 | ⑦ | TB5-L0 | ② |
| -8 | X20F4N | 4 | 16.00 | BLK MKG | TB5-L0 | ② | GND STUD | ③ |

|  |  |  |  |
|---|---|---|---|
| 7 | 1 | TERMINAL, LUG, CRIMP TYPE |  |
| 6 | AR | WIRE, AN4, COLOR WHITE | MIL-W-5086/2 |
| 5 | AR | WIRE, AN 2/0, COLOR WHITE | MIL-W-5086/2 |
| 4 | 3 | TERMINAL, LUG, CRIMP TYPE |  |
| 3 | 1 | TERMINAL, LUG, CRIMP TYPE |  |
| 2 | 2 | TERMINAL, LUG, CRIMP TYPE |  |
| 1 | 9 | TERMINAL, LUG, CRIMP TYPE |  |
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |

LIST OF MATERIAL

ME 6115-545-34/5-11 C1

Figure 5-11. Special AC Power Cables


CT5
1
3
1.25
1.62
6.38
CT6
1
3
2.00
1.00
5.50
3.00
2.75
4.00
1.50
6.50
CT7
1
2
6.75
1.50
1.00
CT4
1
3
6.25
1.50
1.00
1.75
5.50
1.25
1.00
3 PLACES
.50
7 PLACES
1.25
1 1 3 3 5 6 7 8 9 10 11 11 13 14
TB 16
3.38
1.88
1.75
1.88
1.88
2.00
.25
2.00
CT3
CT2
CT1
A1
A2
B1
B2
C1
C2

NOTES:

1. INTERPRET DWG PER MIL-STD-100.
2. ALL WIRE ④ SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ③. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.

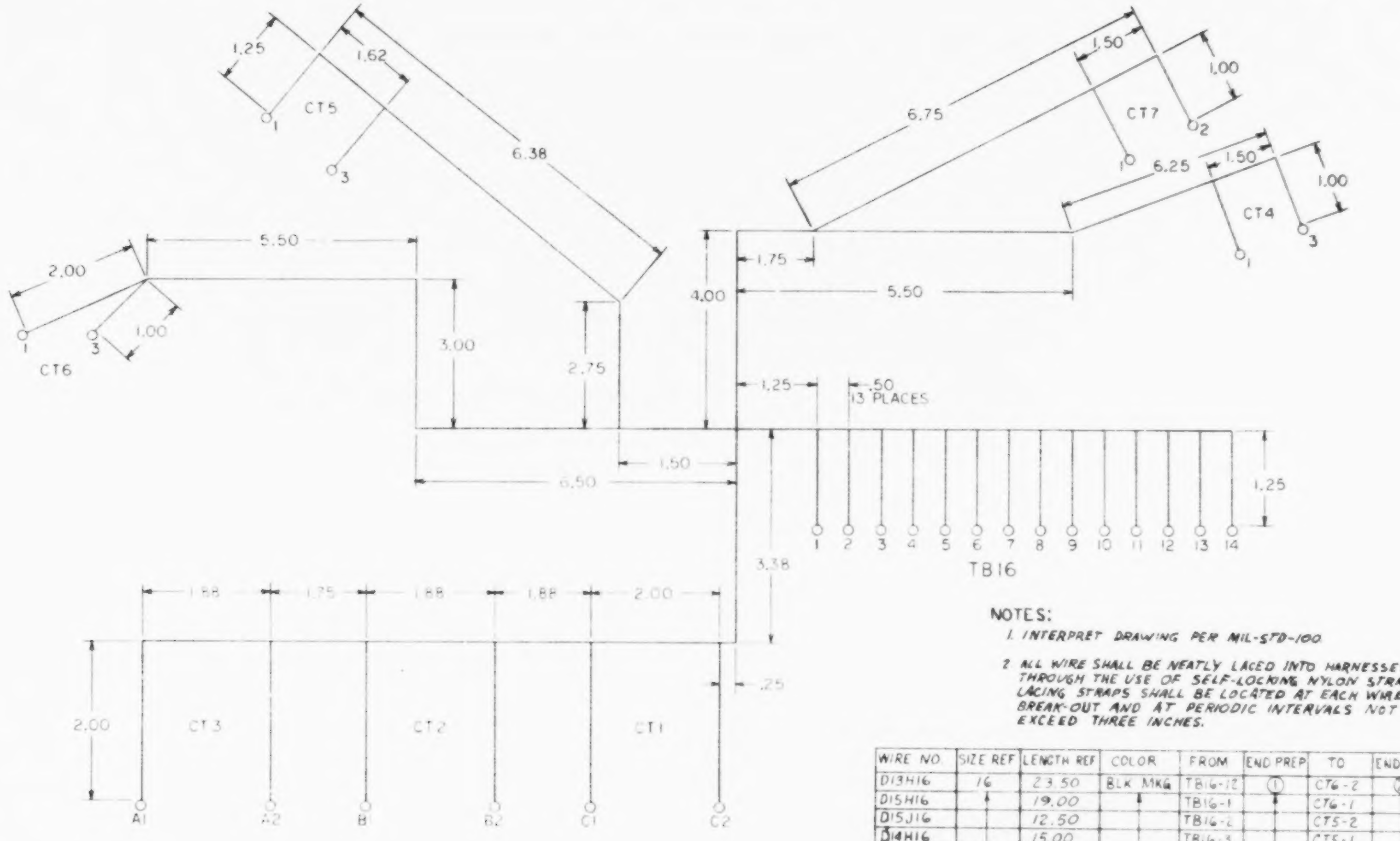
| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| D13H16 | 16 | 23.50 | BLK MKG | TB16-11 | ① | CT6-3 | ② |
| D15H16 | ↑ | 19.00 | ↑ | TB16-1 | ↑ | CT6-1 | ↑ |
| D15J16 | | 12.50 | | TB16-1 | | CT5-3 | |
| D14H16 | | 15.00 | | TB16-3 | | CT5-1 | |
| D14J16 | | 19.00 | | TB16-3 | | CT4-3 | |
| D13J16 | | 20.75 | | TB16-11 | | CT4-1 | |
| D22E16 | | 15.75 | | TB16-5 | | CT3-A2 | |
| X19F16 | | 18.75 | | TB16-6 | | CT3-A1 | |
| D21E16 | | 13.50 | | TB16-7 | | CT2-B2 | |
| X18F16 | | 15.75 | | TB16-8 | | CT2-B1 | |
| D20E16 | | 10.75 | | TB16-9 | | CT1-C2 | |
| X17F16 | | 12.75 | | TB16-10 | | CT1-C1 | |
| X195N16 | ↓ | 19.50 | ↓ | TB16-14 | ↓ | CT7-1 | ↓ |
| X194G16 | 16 | 20.00 | BLK MKG | TB16-13 | ① | CT7-2 | ② |

| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 4 | AR | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| 3 | AR | STRAP, CABLE, ADJUSTABLE | |
| 2 | 14 | TERMINAL, LUG, CRIMP STYLE | |
| 1 | 14 | TERMINAL, LUG, CRIMP STYLE | |

LIST OF MATERIAL

ME 6115-545-34/5-12 C1

Figure 5-12. Current Transformer Assembly Mode I Sets Wiring Harness


1.25
1.62
CT5
1
3
6.38
6.75
1.50
1.00
CT7
1
2
6.25
1.50
1.00
CT4
1
3
5.50
2.00
1.00
1
3
CT6
3.00
2.75
4.00
1.75
5.50
1.25
.50
13 PLACES
1.50
6.50
1.25
1 2 3 4 5 6 7 8 9 10 11 12 13 14
TB16
3.38
1.88
1.75
1.88
1.88
2.00
.25
2.00
CT3
CT2
CT1
A1
A2
B1
B2
C1
C2

NOTES:

1. INTERPRET DRAWING PER MIL-STD-100

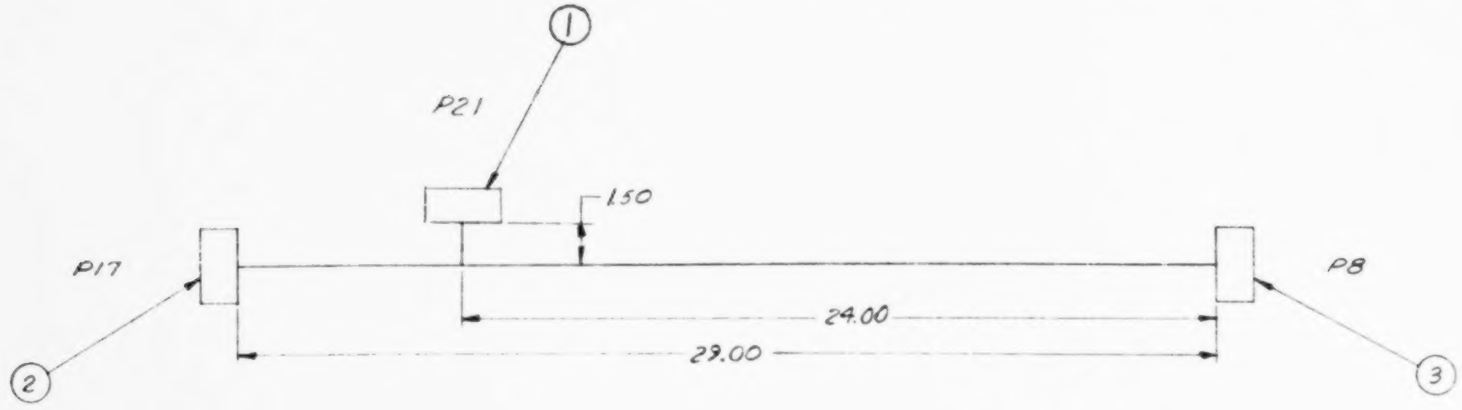
2. ALL WIRE SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ③ LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| D13H16 | 16 | 23.50 | BLK MKG | TB16-12 | ① | CT6-2 | ② |
| D15H16 |  | 19.00 |  | TB16-1 |  | CT6-1 |  |
| D15J16 |  | 12.50 |  | TB16-2 |  | CT5-2 |  |
| D14H16 |  | 15.00 |  | TB16-3 |  | CT5-1 |  |
| D14J16 |  | 19.00 |  | TB16-4 |  | CT4-2 |  |
| D13J16 |  | 20.75 |  | TB16-11 |  | CT4-1 |  |
| D22E16 |  | 15.75 |  | TB16-5 |  | CT3-A2 |  |
| X19F16 |  | 18.75 |  | TB16-6 |  | CT3-A1 |  |
| D21E16 |  | 13.50 |  | TB16-7 |  | CT2-B2 |  |
| X18F16 |  | 15.75 |  | TB16-8 |  | CT2-B1 |  |
| D20E16 |  | 10.75 |  | TB16-9 |  | CT1-C2 |  |
| X17F16 |  | 12.75 |  | TB16-10 |  | CT1-C1 |  |
| X195N16 |  | 19.50 |  | TB16-14 |  | CT7-1 |  |
| X194G16 | 16 | 20.00 | BLK MKG | TB16-13 | ① | CT7-2 | ② |

| | | | | |
|---|---|---|---|---|
| 4 | AR | WIRE AN-16, COLOR WHITE | MIL-W-5086 |  |
| 3 | AR | STRAP, CABLE, ADJUSTABLE |  |  |
| 2 | 14 | TERMINAL LUG, CRIMP STYLE |  |  |
| [illegible] | 14 | TERMINAL LUG, CRIMP STYLE |  |  |
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION | MATERIAL |
| LIST OF MATERIAL | | | | |

ME 6115-545-34/5-13 C1

Figure 5-13. Current Transformer Assembly Mode II Sets Wiring Harness



NOTES :

1. INTERPRET DRAWING PER MIL-STD-100.
2. WIRING SHALL BE NEATLY LACED THROUGH THE USE OF SELF-LOCKING NYLON STRAPS LOCATED AT INTERVALS NOT TO EXCEED THREE INCHES BETWEEN STRAPS ⑤⑥.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. INSTALL NYLON FILLER PLUGS ⑦ IN UNUSED OPENINGS OF CONNECTOR BUSHING

ME 6115-545-34/5-14(1)

Figure 5-14. Electric Governor Control (Class 1 Mode I) Sets, Wiring Harness (Sheet 1 of 2)

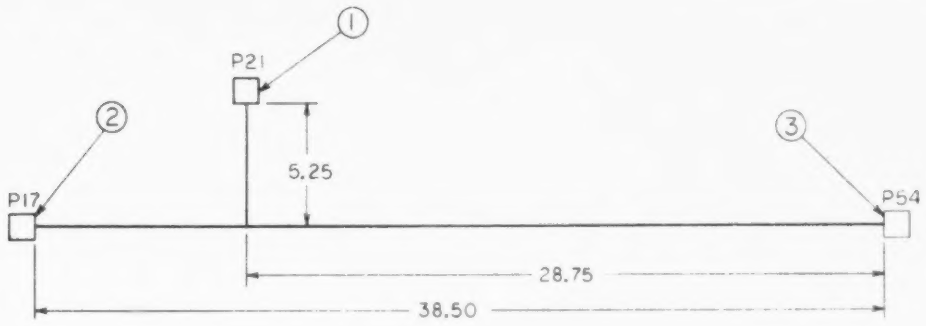
| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X9CC16C | 16 | 30.50 | BLK MKG | P8-A | SOLDER | P17-A | SOLDER |
| X12T16N | ↑ | 30.50 | BLK MKG | P8-B | ↑ | P17-B | ↑ |
| P85A16 |  | 25.50 | RED MKG | P8-C |  | P21-A |  |
| P55R16 |  | 25.50 | RED MKG | P8-D |  | P21-B |  |
| K105B16 |  | 30.50 | BLK MKG | P8-E |  | P17-E |  |
| K107B16 |  | ↑ | ↑ | P8-F |  | P17-F |  |
| K106B16 |  |  |  | P8-H |  | P17-H |  |
| K110A16 |  |  |  | P8-G |  | P17-G |  |
| K111A16 |  |  |  | P8-J |  | P17-J |  |
| K114A16 |  |  |  | P8-K |  | P17-K |  |
| K115A16 |  |  |  | P8-L |  | P17-L |  |
| K32B16 |  |  |  | P8-M |  | P17-M |  |
| K103B16 |  |  |  | P8-N |  | P17-N |  |
| K108B16 |  |  |  | P8-P |  | P17-P |  |
| K109B16 |  |  |  | P8-R |  | P17-R |  |
| K102D16 |  |  |  | P8-S |  | P17-S |  |
| K104B16 |  | ↓ |  | P8-T |  | P17-T |  |
| K101D16 | ↓ | 30.50 | ↓ | P8-U | ↓ | P17-U | ↓ |
| JUMPER | 16 | 7.50 | BLK MKG | P17-C | SOLDER | P17-D | SOLDER |

| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 7 | 7 | PLUG, END SEAL, ELEC CONN |  |
| 6 | AR | STRAP, CABLE, ADJUSTABLE |  |
| 5 | AR | STRAP, CABLE, ADJUSTABLE |  |
| 4 | AR | WIRE, A[illegible]-16, COLOR WHITE | MIL-W-5086/2 |
| 3 | 1 | CONNECTOR, PLUG, ELEC STR |  |
| 2 | 1 | CONNECTOR, PLUG, ELEC STR |  |
| 1 | 1 | CONNECTOR, PLUG, ELEC STR |  |

LIST OF MATERIAL

ME 6115-545-34/5-14(2)

Figure 5-14. Electric Governor Control (Class 1 Mode I) Sets, Wiring Harness (Sheet 2 of 2)



| 8 | AR | SOLDER | QQ-S-571 |
|---|---|---|---|
| 7 | | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| 6 | AR | STRAP, CABLE, ADJUSTABLE | |
| 5 | AR | STRAP, CABLE, ADJUSTABLE | |
| 4 | 7 | PLUG, END SEAL, ELEC CONN | |
| 3 | 1 | CONNECTOR, PLUG, ELEC, STR | |
| 2 | 1 | CONNECTOR, PLUG, ELEC, STR | |
| 1 | 1 | CONNECTOR, PLUG, ELEC, STR | |
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIAL | | | |

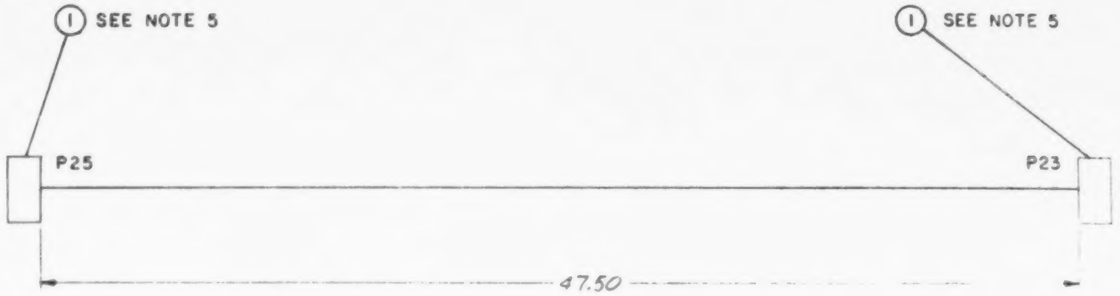
| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X9CC16C | 16 | 40.00 | BLK MKG | P54-A | SOLDER | P17-A | SOLDER |
| X12T16N | ↑ | 40.00 | BLK MKG | P54-B | ↑ | P17-B | ↑ |
| P81A16 | | 35.50 | RED MKG | P54-C | | P21-A | |
| P55R16N | | 35.50 | RED MKG | P54-D | | P21-B | |
| K105B16 | | 40.00 | BLK MKG | P54-E | | P17-E | |
| K107B16 | | ↑ | ↑ | P54-F | | P17-F | |
| K106B16 | | | | P54-H | | P17-H | |
| K110A16 | | | | P54-G | | P17-G | |
| K117A16 | | | | P54-J | | P17-J | |
| | | | | | | | |
| | | | | | | | |
| K32B16 | | | | P54-M | | P17-M | |
| K103B16 | | | | P54-N | | P17-N | |
| K108B16 | | | | P54-P | | P17-P | |
| K109B16 | | | | P54-R | | P17-R | |
| K102D16 | | | | P54-S | | P17-S | |
| K104B16 | | ↓ | | P54-T | | P17-T | |
| K101D16 | ↓ | 40.00 | | P54-U | ↓ | P17-U | ↓ |
| JUMPER | 16 | 10.00 | BLK MKG | P17-C | SOLDER | P17-D | SOLDER |

NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. WIRING SHALL BE NEATLY LACED THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ⑤⑥, LOCATED AT INTERVALS NOT TO EXCEED THREE INCHES BETWEEN STRAPS.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES
5. INSTALL NYLON FILLER PLUGS ④ IN UNUSED OPENINGS OF CONNECTOR BUSHING.

ME 6115-545-34/5-15

Figure 5-15. Electric Governor Control (Class 1 Mode II) Sets, Wiring Harness



| 4 | 2 | PLUG, END, SEAL, ELEC CONN | |
|---|---|---|---|
| 3 | AR | STRAP, CABLE, ADJUSTABLE | |
| 2 | AR | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| 1 | 2 | CONNECTOR, PLUG, ELEC STR | |
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIAL | | | |

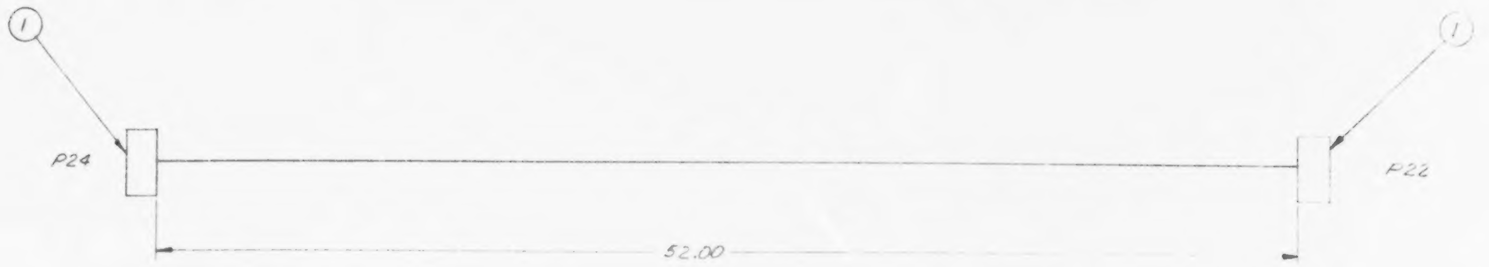
| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| K124A16 | 16 | 49.00 | BLK MKG | P23-A | SOLDER | P25-A | SOLDER |
| K125A16 | ↑ | ↑ | ↑ | P23-B | ↑ | P25-B | ↑ |
| K126A16 | ↓ | ↓ | ↓ | P23-C | ↓ | P25-C | ↓ |
| K127A16 | 16 | 49.00 | BLK MKG | P23-D | SOLDER | P25-D | SOLDER |

NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. WIRING ② SHALL BE NEATLY LACED THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ③ LOCATED AT INTERVALS NOT TO EXCEED THREE (3) INCHES BETWEEN STRAPS.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. INSTALL ④ NYLON FILLER PLUGS IN UNUSED OPENINGS OF CONNECTOR BUSHING.

ME 6115-545-34/5-16

Figure 5-16. Electric Governor Control To Actuator Wiring Harness, Class 1 Sets



| | | | |
|---|---|---|---|
| 4 | AR | PLUG, END SEAL, ELEC CONN | |
| 3 | AR | STRAP, CABLE, ADJUSTABLE | |
| 2 | AR | WIRE, AN16, COLOR WHITE | MIL-W-5086/2 |
| 1 | 2 | CONNECTOR, PLUG, ELEC STR | |
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| | LIST OF MATERIAL | | |

| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| K120A16 | 16 | 53.50 | BLK MKG | P22-A | SOLDER | P24-A | SOLDER |
| K121A16 | ↕ | ↕ | ↕ | P22-B | ↕ | P24-B | ↕ |
| K122A16 | | | | P22-C | | P24-C | |
| K123A16 | 16 | 53.50 | BLK MKG | P22-D | SOLDER | P24-D | SOLDER |

NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. WIRING ② SHALL BE NEATLY LACED THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ③, LOCATED AT INTERVALS NOT TO EXCEED THREE (3) INCHES BETWEEN STRAPS.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.

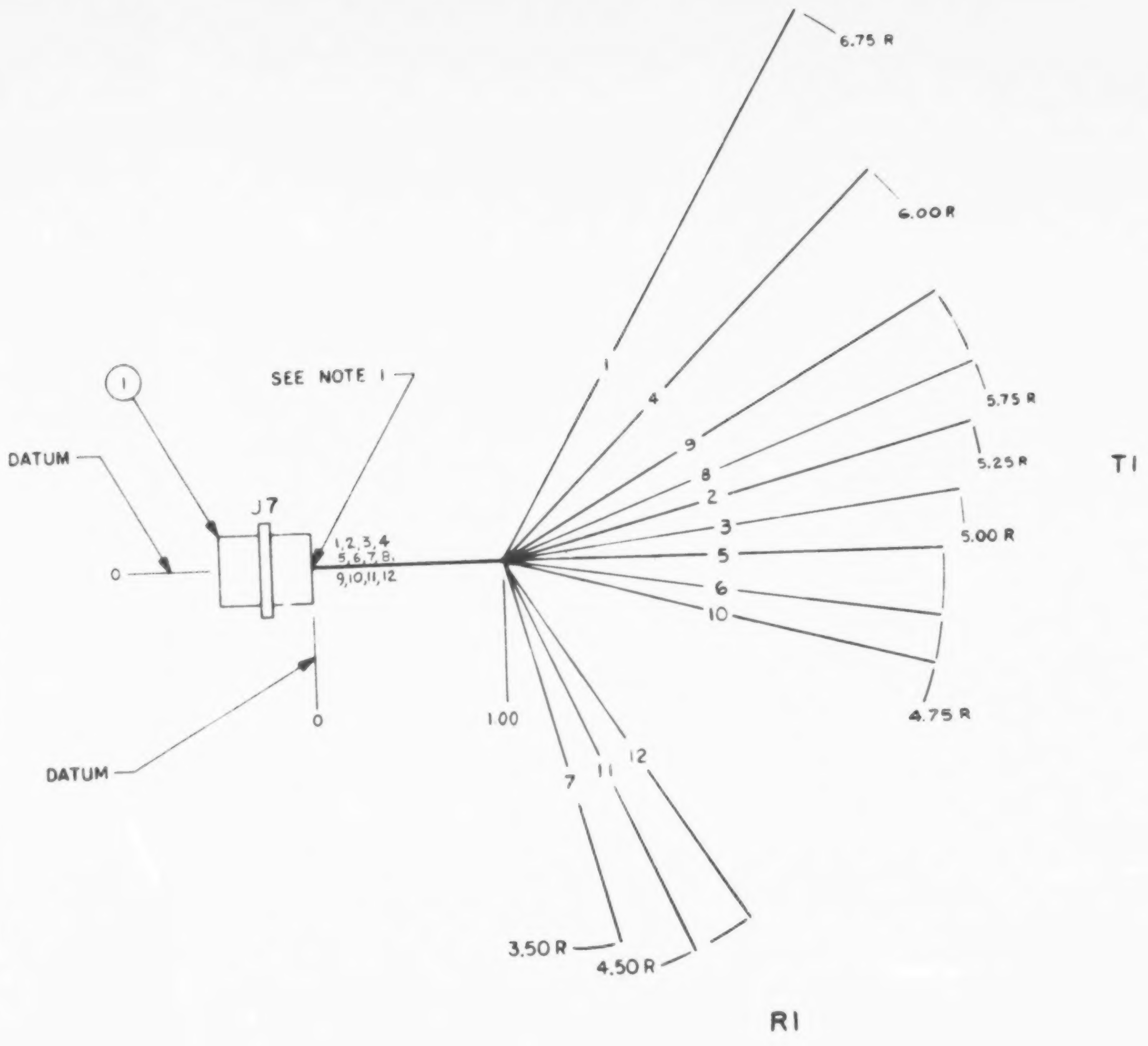
5. INSTALL ④ NYLON FILLER PLUGS IN UNUSED OPENINGS OF CONNECTOR BUSHING.

ME 6115-545-34/5-17

Figure 5-17. Electric Governor Control To Actuator Class 1 Sets Feedback Cable

| WIRES IN HARNESS | | | |
|---|---|---|---|
| WIRE NO. REF | TERMINATION | | WIRE CUT LENGTH REF |
| | FROM | TO | |
| 1 | J7-A | T1-2 | 8.25 |
| 2 | J7-B | T1-9 | 6.75 |
| 3 | J7-C | T1-16 | 6.50 |
| 4 | J7-D | T1-6 | 7.50 |
| 5 | J7-E | T1-13 | 6.25 |
| 6 | J7-F | T1-20 | 6.25 |
| 7 | J7-G | R1-3 | 5.00 |
| 8 | J7-K | T1-1 | 7.25 |
| 9 | J7-L | T1-8 | 7.25 |
| 10 | J7-M | T1-15 | 6.25 |
| 11 | J7-N | R1-1 | 6.00 |
| 12 | J7-S | R1-2 | 6.00 |

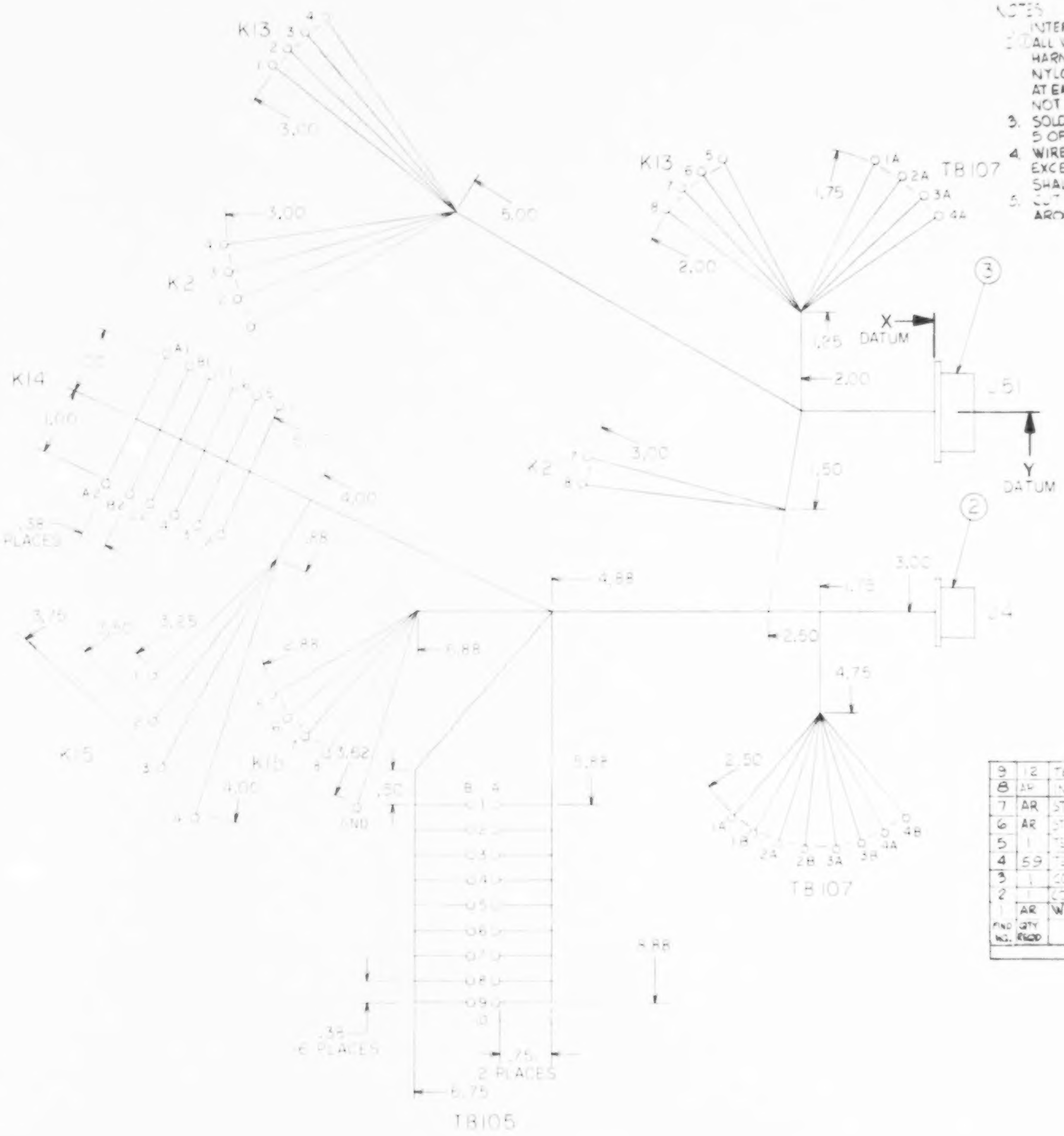
| | | | |
|---|---|---|---|
| 4 | AR | INSULATION SLEEVING, ELEC, HEAT | MIL-I-23053/2 |
| | | SHRINKABLE, POLYVINYL CHLORIDE, FLEX., | |
| | | CROSSLINKED, .993 MIN ID, AS SUPPLIED, | |
| | | .046 MAX ID X .020 NOM WALL, AFTER | |
| | | UNRESTRICTED SHRINKAGE | |
| 3 | 1 | STRAP, CABLE, ADJ, SELF-CLINCHING, | |
| | | PLASTIC, TYPE I, CL 1, 4 MAX BDL DIA, | |
| | | NATURAL | |
| 2 | AR | WIRE, ELEC, TYPE C-20, 105°C, 1000V | MIL-W-16878/2 |
| 1 | 1 | CONN, RECP, DOD MS 3132W-20-29P | |
| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIAL | | | |


6.75 R
6.00 R
5.75 R
5.25 R
T1
5.00 R
4.75 R
SEE NOTE 1
1
DATUM
J7
0
1,2,3,4
5,6,7,8,
9,10,11,12
1
4
9
8
2
3
5
6
10
0
DATUM
1.00
7
11
12
3.50 R
4.50 R
R1

ME 6115-545-34/5-18

Figure 5-18. Load Measuring Unit, Wiring Harness

| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X7B16 | 16 | 16,00 | BLK MKG | J51-T | SOLDER | K14-A1 | ⑨ |
| P200Y16 | | 6,00 | RED MKG | TB105-9B | ④ | K13-8 | ④ |
| P200X16 | | 11,25 | RED MKG | TB105-8B | ④ | K15-5 | ④ |
| K102H16 | | 10,50 | BLK MKG | TB105-6A | ④ | J4-S | SOLDER |
| K102E16 | | 5,00 | | J51-N | SOLDER | TB105-6B | ④ |
| K101H16 | | 11,00 | | TB105-7A | ④ | J4-N | SOLDER |
| K101G16 | | 14,50 | | TB105-7B | ④ | K15-2 | ④ |
| K101E16 | | 14,75 | BLK MKG | J51-X | SOLDER | TB105-7B | ④ |
| P55KL16N | | 3,75 | RED MKG | TB105-5B | ④ | K14-2(-) | ⑨ |
| P55JJ16N | | 4,00 | | TB105-5A | ④ | K15-4 | ④ |
| P55LL16N | | 4,50 | | J51-M | SOLDER | TB105-5B | ④ |
| P55W16 | | [illegible] | | TB105-4A | ④ | K14-1 | ⑨ |
| P55[illegible]16 | | [illegible] | RED MKG | J51-L | SOLDER | TB105-4B | ④ |
| X12V16N | | 9,50 | BLK MKG | TB105-3A | ④ | J4-K | SOLDER |
| X12DD16N | | 11,00 | | TB105-3B | ④ | J4-L | SOLDER |
| X12F16N | | 17,50 | | TB105-2B | ④ | K2-2 | ④ |
| X12X16N | | 8,50 | | TB105-2A | ④ | J4-M | SOLDER |
| X12P16L | | [illegible] | | J51-K | SOLDER | TB105-2B | ④ |
| X9V16C | | 6,50 | | TB105-1B | ④ | K2-1 | ④ |
| X9T16C | | 8,50 | | TB105-1A | ④ | J4-C | SOLDER |
| X9U16C | | 12,25 | BLK MKG | J51-J | SOLDER | TB105-1B | ④ |
| P62J16 | | 5,25 | RED MKG | J51-[illegible] | | K13-6 | ④ |
| P62H16 | | 14,50 | | J51-H | | K14-6 | ⑨ |
| P209D16 | | 14,75 | | J51-G | | K14-4 | ⑨ |
| P203D16 | | 5,75 | | J51-F | SOLDER | K13-7 | ④ |
| P61A16 | | 8,50 | | K15-8 | ④ | K14-5 | ⑨ |
| P60B16 | | 12,25 | | J51-E | SOLDER | K15-7 | ④ |
| P205D16 | | 12,25 | | J51-D | SOLDER | K15-6 | ④ |
| P200T16 | | 2,50 | | TB105-9A | ④ | K14-3 | ⑨ |
| P200V16 | | 2,00 | | TB105-8A | ④ | K2-8 | ④ |
| P200S16 | | 15,25 | | J51-P | SOLDER | TB105-8B | ④ |
| P206D16 | | 6,00 | | J51-C | | K2-7 | ④ |
| P50X16 | | 10,00 | | J51-B | | K2-4 | ④ |
| P58B16 | | 9,50 | RED MKG | J51-A | | K2-3 | ④ |
| X18B16 | | 15,75 | BLK MKG | J51-U | | K14-B1 | ⑨ |
| X5VV16B | | 8,00 | BLK MKG | J51-R | | J4-B | SOLDER |
| X7VV16A | | 8,00 | BLK MKG | J51-S | | J4-A | SOLDER |
| P63A16 | | 5,75 | RED MKG | J51-a | SOLDER | K13-5 | 4 |
| P50GG16 | | 13,00 | RED MKG | TB105-4A | ④ | K15-3 | ④ |
| D24H16 | | 5,00 | BLK MKG | J51-[illegible] | SOLDER | TB107-4A | ④ |
| D24F16 | | 4,00 | | K13-4 | ④ | TB107-4B | ④ |
| D24E16 | | 6,50 | | TB107-4A | ④ | J4-G | SOLDER |
| X117C16 | | 15,00 | | K13-3 | ④ | TB107-3B | ④ |
| X117B16 | | 16,50 | | K14-C2 | ⑨ | TB107-3A | ④ |
| X117A16 | | 5,25 | | TB107-3A | ④ | J4-F | SOLDER |
| X116A16 | | 5,50 | | TB107-2A | ④ | J4-E | SOLDER |
| X116C16 | | 15,50 | | K13-2 | ④ | TB107-2B | ④ |
| X116B16 | | 17,00 | | K14-B2 | ⑨ | TB107-2A | ④ |
| X115A16 | | 5,25 | | TB107-1A | ④ | J4-D | SOLDER |
| X115B16 | | 17,50 | | K14-A2 | ⑨ | TB107-1A | ④ |
| X115C16 | | 16,00 | BLK MKG | K13-1 | ④ | TB107-1B | ④ |
| P55AX16N | | 13,00 | RED MKG | J51-W | SOLDER | GND STUD | ⑤ |
| X19B16 | | 15,50 | BLK MKG | J51-V | SOLDER | K14-C1 | ⑨ |
| K102G16 | | 13,75 | BLK MKG | TB105-6B | ④ | K15-1 | ④ |



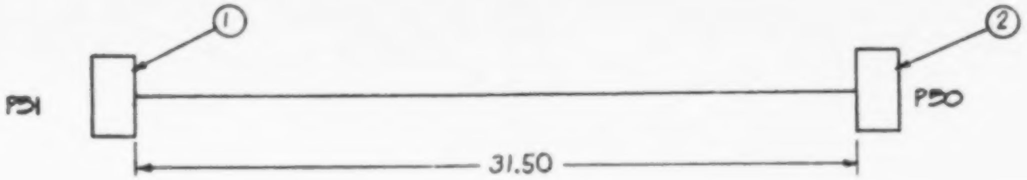
NOTES:
1. INTERPRET DRAWING PER MIL-STD-100.
2. ALL WIRE SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING ⑥⑦ NYLON STRAPS. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. CUT INSULATION TUBING IN HALF-INCH PIECES AND INSTALL AROUND WIRE AND PINS AT RECEPTACLES ⑧

| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 9 | 12 | TERMINAL LUG CRIMP STYLE | |
| 8 | AR | INSUL SLEEVING, .12 I.D. BLACK | MIL-I-23053/5 CLASS 1 |
| 7 | AR | STRAP CABLE ADJUSTABLE | |
| 6 | AR | STRAP CABLE, ADJUSTABLE | |
| 5 | 1 | TERMINAL, LUG, CRIMP STYLE | |
| 4 | 59 | TERMINAL LUG CRIMP STYLE | |
| 3 | 1 | CONNECTOR, RECEPT, ELEC | |
| 2 | 1 | CONNECTOR, RECEPT, ELEC | |
| 1 | AR | WIRE AN 16, COLOR WHITE | MIL-W-5086/2 |

LIST OF MATERIAL

ME 6115-545-34/5-19 C1

Figure 5-19. Tactical Relay Assembly, Wiring Harness



| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| P58A16 | 16 | 33.00 | RED MKG | P50-A | SOLDER | P51-A | SOLDER |
| P50PP16 | | | | -B | | -B | |
| P206C16 | | | | -C | | -C | |
| P205C16 | | | | -D | | -D | |
| P209C16 | | | | -G | | -G | |
| P62G16 | | | RED MKG | -H | | -H | |
| X9M16C | | | BLACK MKG | -J | | -J | |
| X12T16N | | | BLACK MKG | -K | | -K | |
| P502C16 | | | RED MKG | -L | | -L | |
| P55TR16N | | | BLACK MKG | -M | | -M | |
| K102B16 | | | BLACK MKG | -N | | -N | |
| P200M16 | | | RED MKG | -P | | -P | |
| X8P16B | | | BLACK MKG | -R | | -R | |
| X7P16A | | | | -S | | -S | |
| X17A16 | | | | -T | | -T | |
| X18A16 | | | | -U | | -U | |
| X19A16 | | | BLACK MKG | -V | | -V | |
| P55AW16 | | | RED MKG | -W | | -W | |
| K101B16 | | | BLACK MKG | -X | | -X | |
| | | | | | | | |
| P63B16 | | | RED MKG | -a | | -a | |
| P62[illegible]16 | | | RED MKG | -b | | -b | |
| D24J16 | | | BLACK MKG | -c | | -c | |
| P60E16 | | | RED MKG | -e | | -e | |
| P203C16 | 16 | 33.00 | RED MKG | P50-F | SOLDER | P51-F | SOLDER |
| | | | | | | | |

| | | | |
|---|---|---|---|
| 5 | 2 | PLUG, END SEAL, ELEC CONN | |
| 4 | AR | STRAP, CABLE, ADJUSTABLE | |
| 3 | AR | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| 2 | 1 | CONNECTOR, PLUG, ELEC STR | |
| 1 | 1 | CONNECTOR, PLUG, ELEC STR | |
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| | | LIST OF MATERIAL | |

NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. WIRING SHALL BE NEATLY LACED THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ④, LOCATED AT INTERVALS NOT TO EXCEED THREE INCHES BETWEEN STRAPS.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. INSTALL NYLON FILLER PLUGS ⑤ IN UNUSED OPENINGS OF CONNECTORS.

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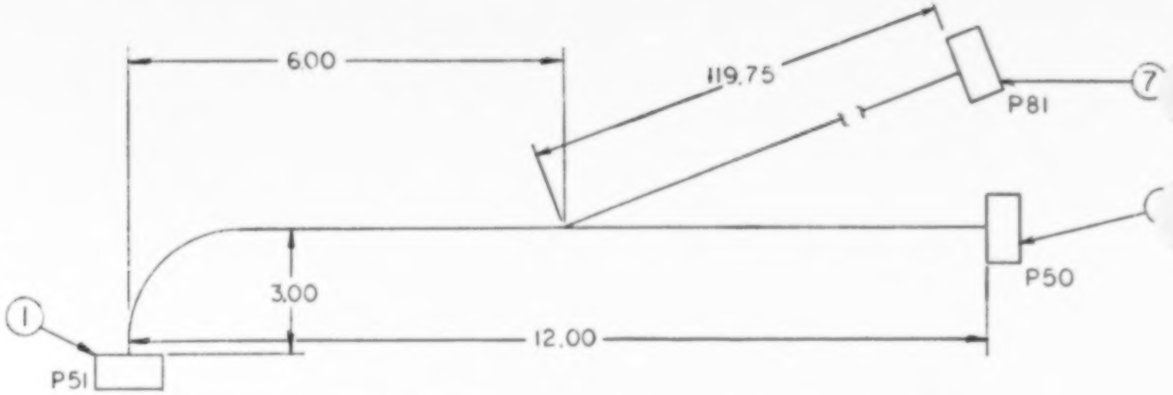
Figure 5-20. Tactical Relay Assembly, Interconnecting Wiring Harness



| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| P58A16 | 16 | 13.95 | RED MKG | P50-A | SOLDER | P51-A | SOLDER |
| P50PP16 | | | | -B | | -B | |
| P206C16 | | | | -C | | -C | |
| P205C16 | | | | -D | | -D | |
| P209C16 | | | | -G | | -G | |
| P62G16 | | | RED MKG | -H | | -H | |
| X9M16C | | | BLK MKG | -J | | -J | |
| X12T16N | | 13.95 | BLK MKG | -K | | P51-K | |
| P50CC16 | | 126.00 | RED MKG | -L | | P81-C | |
| P55TR16N | | 126.00 | RED MKG | -M | | P81-H | |
| K102B16 | | 126.00 | BLK MKG | -N | | P81-F | |
| P200M16 | | 13.95 | RED MKG | -P | | P51-P | |
| X6F16B | | | BLK MKG | -R | | -R | |
| X7F16A | | | | -S | | -S | |
| X17A16 | | | | -T | | -T | |
| X18A16 | | | | -U | | -U | |
| X19A16 | | | BLK MKG | -V | | -V | |
| P55AW16 | | 13.95 | RED MKG | -W | | P51-W | |
| K101B15 | | 126.00 | BLK MKG | P50-X | | P81-E | |
| P50JJ16 | | 127.70 | RED MKG | P81-G | | P51-L | |
| P68B16 | | 13.95 | RED MKG | P50-a | | P51-a | |
| P62DD16 | | | RED MKG | -b | | -b | |
| D24J16 | | | BLK MKG | -d | | -d | |
| P60E16 | | | RED MKG | -E | | -E | |
| P203C16 | | 13.95 | RED MKG | P50-F | | -F | |
| K101X16 | | 127.70 | BLK MKG | P81-A | | -X | |
| K102X16 | | | BLK MKG | -B | | -N | |
| | | | | | | | |
| P55YZ16 | 16 | 127.70 | RED MKG | P81-D | SOLDER | P51-M | SOLDER |

| | | | |
|---|---|---|---|
| 7 | 1 | CONNECTOR, PLUG ELEC | |
| 6 | | | |
| 5 | 2 | PLUG, END SEAL, ELEC CONN | |
| 4 | AR | STRAP, CABLE ADJUSTABLE | |
| 3 | AR | WIRE, AN-16 COLOR, WHITE | MIL-W-5086/2 |
| 2 | 1 | CONN, PLUG, ELEC STR | |
| 1 | 1 | CONN, PLUG, ELEC STR | |
| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIALS | | | |

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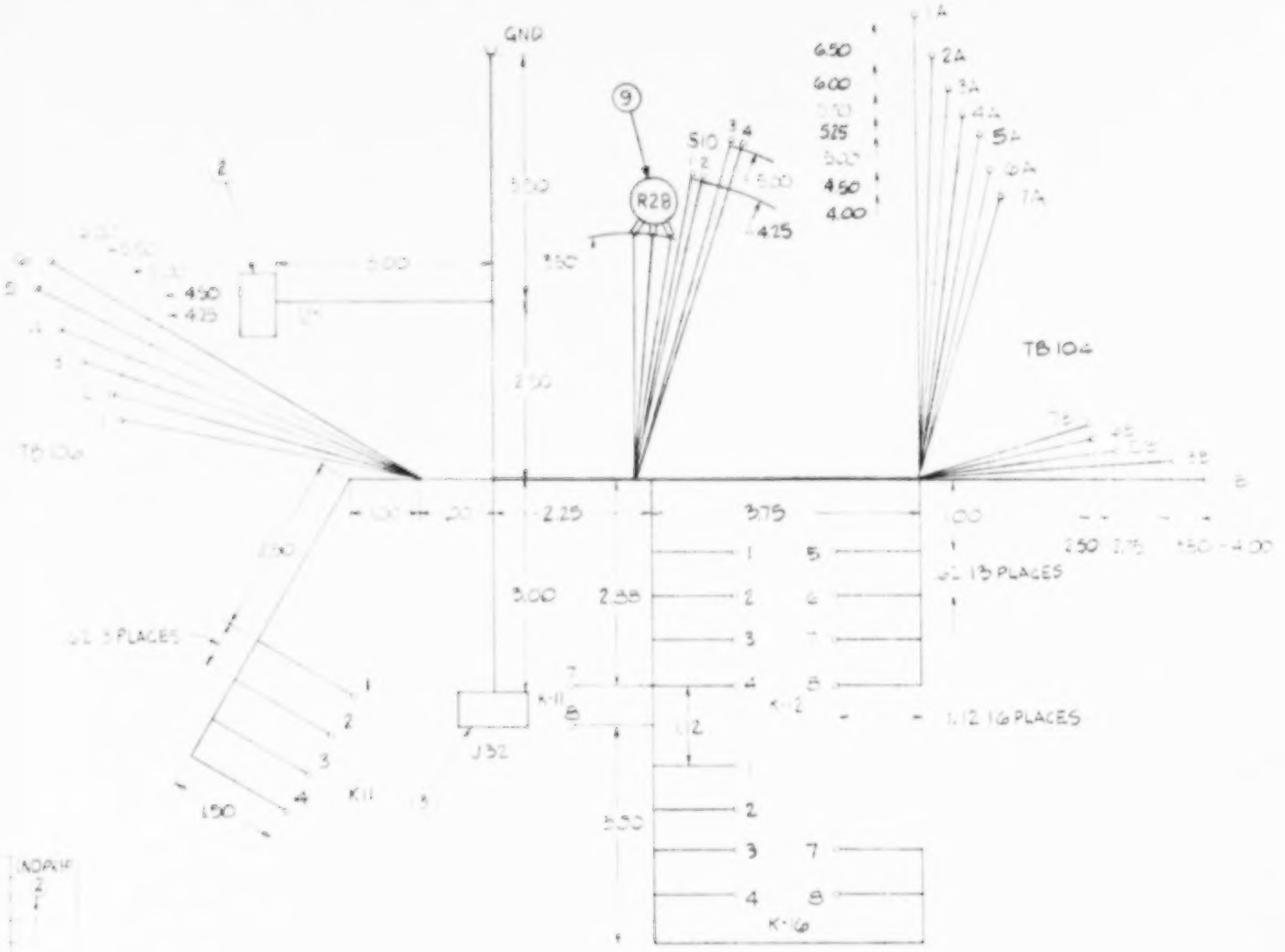
Figure 5-21. Load Bank Interconnect, Tactical Relay

| | | | |
|---|---|---|---|
| 8 | AR | INSUL SLEEVING .12 ID BLACK | MIL-I-23053/5 CLASS 1 |
| 7 | AR | STRAP, CABLE ADJUSTABLE | |
| 6 | AR | STRAP, CABLE ADJUSTABLE | |
| 5 | 3 | TERMINAL, LUG CRIMP STYLE | |
| 4 | 47 | TERMINAL, LUG, CRIMP STYLE | |
| 3 | | CONNECTOR, RECEPT ELEC | |
| 2 | 1 | CONNECTOR, RECEPT ELEC | |
| 1 | AR | WIRE 16 AWG COLOR WHITE | MIL-W-5086/2 |
| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| | | LIST OF MATERIAL | |

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X9P16C | 16 | 16.00 | BLACK MKG | J32-A | SOLDER | TB104-1A | ④ |
| X9S16C | | 5.00 | | TB104-2A | ② | [illegible] | SOLDER |
| X12R16N | | 15.00 | | J32-B | SOLDER | TB104-3A | ② |
| X12U16N | | 17.00 | BLACK MKG | TB104-4A | ② | [illegible] | SOLDER |
| P8E16 | | 8.75 | RED MKG | J32-C | SOLDER | J8-C | SOLDER |
| P55YY16N | | 13.75 | | J32-D | SOLDER | TB104-6A | ② |
| P55S16N | | 16.25 | | TB104-6A | ② | J8-D | SOLDER |
| P50A16 | | 14.25 | | J32-E | SOLDER | TB104-5A | ② |
| P26D16 | | 10.00 | RED MKG | J32-F | | K11-3 | ② |
| K110B16 | | 9.75 | BLACK MKG | J32-G | | J8-G | SOLDER |
| P20C16 | | 10.00 | RED MKG | J32-H | | K11-7 | ② |
| K111B16 | | 8.75 | BLACK MKG | J32-J | | J8-J | SOLDER |
| P200K16 | | 13.50 | RED MKG | J32-K | | TB104-7A | ④ |
| P57J16 | | 7.75 | RED MKG | J32-L | | K16-8 | ④ |
| K32E16 | | 8.75 | BLACK MKG | J32-M | | J8-M | SOLDER |
| K33E16 | | 9.00 | | J32-N | | TB106-2 | ② |
| K34E16 | | 10.00 | | J32-T | | TB106-4 | |
| L93F16 | | 11.00 | | J32-P | | K16-1 | |
| X15J16 | | 11.50 | | J32-R | | K16-2 | ④ |
| K102L16 | | 8.75 | | J32-S | | J8-S | SOLDER |
| K101L16 | | 8.75 | BLACK MKG | J32-U | | J8-U | SOLDER |
| P210D16 | | 11.50 | RED MKG | J32-V | | K12-5 | ② |
| P55RR16N | | 9.25 | | J32-Z | SOLDER | GND STUD | ④ |
| P71A16 | | 4.00 | | K11-8 | ④ | K12-3 | ④ |
| P59A16 | | 11.50 | RED MKG | K12-4 | ④ | K16-7 | |
| X9FF16C | 16 | 16.25 | BLACK MKG | TB104-1B | ② | K11-1 | ④ |

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X9E16C | 16 | 10.25 | BLACK MKG | TB104-1B | ② | K12-1 | ② |
| [illegible] | | 16.25 | | TB104-3B | | K11-2 | |
| [illegible] | | 10.25 | BLACK MKG | TB104-3B | | K12-2 | |
| P50AB16 | | 13.00 | RED MKG | TB104-5B | | K16-3 | |
| P55XD16N | | 13.50 | | TB104-6B | | K16-4 | |
| P210P16 | | 6.50 | | TB104-7B | | K12-6 | |
| [illegible] | | 15.75 | RED MKG | TB104-7B | | K11-4 | |
| K144A16 | | 11.75 | BLACK MKG | K12-7 | | S10-1 | |
| K145A16 | | 12.00 | | K12-8 | | S10-2 | ④ |
| K114A16 | | 12.50 | | S10-3 | | J8-K | SOLDER |
| K115A16 | | 12.50 | | S10-4 | | J8-L | |
| K108A16 | | 12.75 | | TB106-5 | | J8-P | |
| K109A16 | | 12.75 | | TB106-6 | ④ | J8-R | |
| K107A16 | | 11.00 | | R28-L | SOLDER | J8-F | |
| K106A16 | | 11.00 | | R28-M | SOLDER | J8-H | |
| K105A16 | | 11.00 | | R28-R | SOLDER | J8-E | |
| K104A16 | | 12.00 | | TB106-3 | ④ | J8-T | |
| K103A16 | 16 | 11.75 | BLACK MKG | TB106-1 | ④ | J8-W | SOLDER |



NOTES:
1. INTERPRET DRAWING PER MIL-STD-100.
2. ALL WIRE SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ⑥⑦. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBER SHALL NOT EXCEED SIX INCHES.
5. CUT INSULATION TUBING IN HALF-INCH PIECES AND INSTALL AROUND WIRES AND PINS AT RECEPTACLES. ⑧
6. FOR WIRING INFORMATION SEE DRAWING 70-1317.

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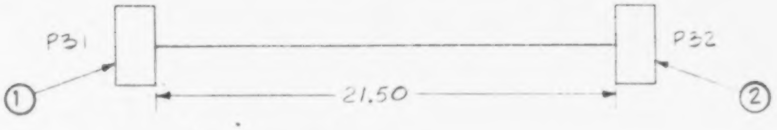
Figure 5-22. Precise Relay Assembly Wiring Harness



| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X9R16C | 16 | 23.00 | BLACK MKG | P31-A | SOLDER | P32-A | SOLDER |
| X12S16N | ↑ | ↑ | BLACK MKG | ↑ -B | ↑ | ↑ -B | ↑ |
| P81C16 | | | RED MKG | C | | C | |
| P55H16N | | | ↑ | -D | | -D | |
| P30U16 | | | ↓ | -E | | E | |
| P204C16 | | | RED MKG | -F | | -F | |
| K110C16 | | | BLACK MKG | -G | | -G | |
| P60D16 | | | RED MKG | H | | -H | |
| K111C16 | | | BLACK MKG | J | | -J | |
| P200F16 | | | RED MKG | -K | | K | |
| P57K16 | | | RED MKG | L | | L | |
| K32D16 | | | BLACK MKG | -M | | M | |
| K33D16 | | | ↑ | -N | | N | |
| K34D16 | | | | -T | | T | |
| L93E16 | | | | -P | | P | |
| X15K16 | | | | -R | | R | |
| K102C16 | | | ↓ | -S | | S | |
| K101C16 | | | BLACK MKG | -U | | U | |
| P210C16 | ↓ | ↓ | RED MKG | ↓ -V | ↓ | ↓ V | ↓ |
| P55K16N | 16 | 23.00 | RED MKG | P31-Z | SOLDER | P32-Z | SOLDER |
| | | | | | | | |

| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 5 | 8 | PLUG, END SEAL, ELEC CONN. | |
| 4 | AR | STRAP, CABLE, ADJUSTABLE | |
| 3 | AR | WIRE AN-16, COLOR WHITE | MIL-W-5086/2 |
| 2 | 1 | CONNECTOR, PLUG, ELEC, STR | |
| 1 | 1 | CONNECTOR, PLUG, ELEC, STR | |

LIST OF MATERIAL

NOTES

1. INTERPRET DRAWING PER MIL-STD-100
2. WIRING SHALL BE NEATLY LACED THROUGH THE USE OF SELF LOCKING NYLON STRAPS ④, LOCATED AT INTERVALS NOT TO EXCEED THREE INCHES BETWEEN STRAPS.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES
5. INSTALL NYLON FILLER PLUGS ⑤ IN UNUSED OPENINGS OF CONNECTOR BUSHING

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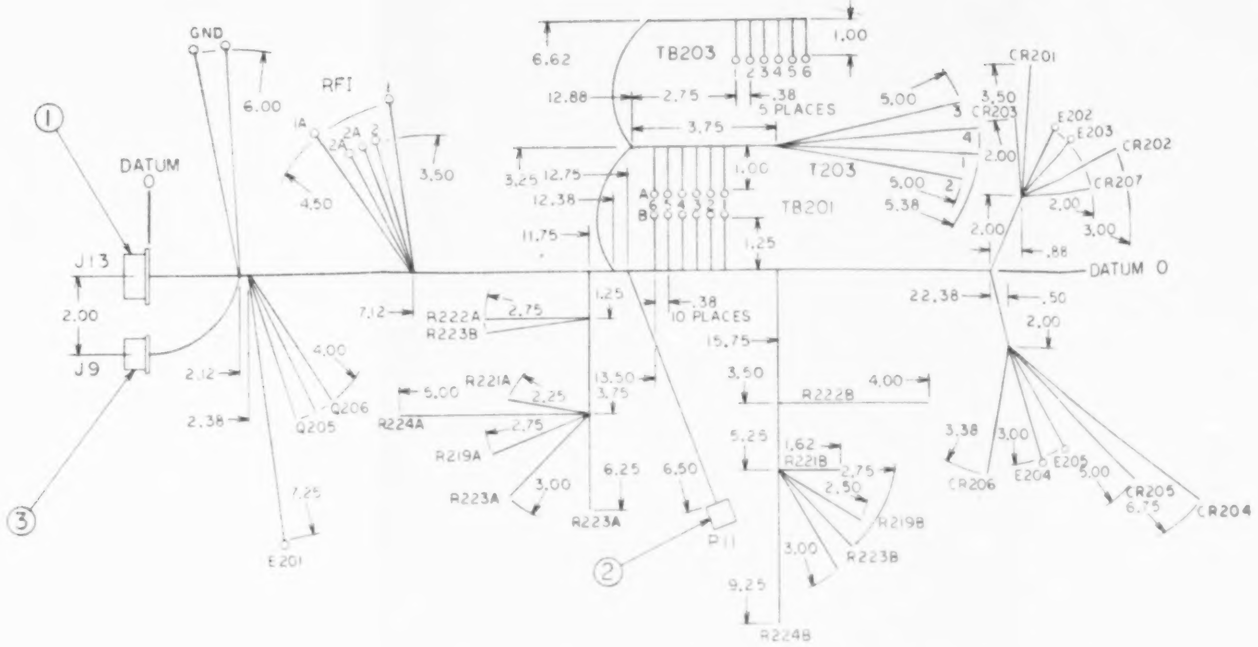
Figure 5-23. Precise Relay Assembly (Class 1 Mode I) Sets, Wiring Harness



GND
6.00
RFI
1A
2A
2
3.50
4.50
①
DATUM
J13
2.00
J9
2.12
2.38
4.00
Q206
Q205
7.25
E201
③
TB203
1 2 3 4 5 6
1.00
6.62
12.88
2.75
.38
5 PLACES
3.75
3.25
12.75
12.38
11.75
1.00
TB201
1.25
T203
5.00
5.38
7.12
R222A
R222B
2.75
R223B
1.25
.38
10 PLACES
R221A
2.25
R224A
5.00
2.75
R219A
R223A
3.00
13.50
3.75
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R223A
②
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R221B
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R219B
3.00
R223B
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R224B
CR201
3.50
CR203
E202
E203
CR202
2.00
CR207
2.00
3.00
.88
2.00
DATUM O
22.38
.50
2.00
3.38
3.00
CR206
E204
E205
5.00
CR205
6.75
CR204

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| D13B16 | 16 | 18.75 | BLK MKG | J13-A | SOLDER | R221A | SOLDER |
| D13C16 | | 5.25 | | R221A | SOLDER | R223A | SOLDER |
| D13D16 | | 10.00 | | R223A | SOLDER | TB201-4A | 5 |
| D13E16 | | 21.00 | | TB201-4B | ⑤ | CR203 | SOLDER |
| D13F16 | | 23.00 | | TB201-4B | ⑤ | CR206 | SOLDER |
| D13G16 | | 15.75 | | TB201-4A | ⑤ | J13-F | SOLDER |
| D14B16 | | 17.25 | | J13-B | SOLDER | TB201-1B | ⑤ |
| D14C16 | | 8.00 | | TB201-1A | ⑤ | T203-2 | SOLDER |
| D14D16 | | 17.75 | | TB201-1A | ⑤ | R224A | |
| D14E16 | | 8.75 | | TB201-1B | ⑤ | R221B | |
| D14F16 | | 5.00 | | R221B | SOLDER | R222B | |
| D14G16 | | 23.50 | | R222B | | J13-C | |
| D15B16 | | 20.00 | | J13-D | | R222A | |
| D15C16 | | 16.50 | | R222A | | R223B | SOLDER |
| D15D16 | | 11.50 | | R223B | SOLDER | TB201-3A | ⑤ |
| D15E16 | | 21.50 | | TB201-3B | ⑤ | CR202 | SOLDER |
| D15F16 | | 24.00 | | TB201-3B | ⑤ | CR205 | SOLDER |
| D15G16 | | 15.50 | | TB201-3A | ⑤ | J13-E | SOLDER |
| X9K16 | | 11.00 | | J13-L | SOLDER | RFI-1 | ⑥ |
| X12R16 | | 10.00 | | J13-M | SOLDER | RFI-2 | ⑥ |
| D10B16 | | 26.75 | | J13-R | SOLDER | E203 | ⑤ |
| D10C16 | | 14.00 | | E202 | ⑤ | TB201-6B | ⑤ |
| D10D16 | | 9.75 | | TB201-6A | ⑤ | TB203-5 | ⑤ |
| D10F16 | 16 | 16.50 | BLK MKG | TB201-6B | ⑤ | Q205-K | SOLDER |

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| D10G16 | 16 | 21.00 | BLK MKG | Q205-K | SOLDER | P11-G | SOLDER |
| D11E16 | | 27.00 | | J13-S | SOLDER | E205 | ⑤ |
| D11D16 | | 14.00 | | E204 | ⑤ | TB201-5B | ⑤ |
| D11C16 | | 11.00 | | TB201-5A | ⑤ | TB203-6 | ⑤ |
| D11F16 | | 20.00 | | TB203-6 | ⑤ | P11-E | SOLDER |
| D11L16 | | 11.25 | | TB201-5A | ⑤ | RFI-2A | ⑥ |
| D11J16 | | 12.25 | BLK MKG | RFI-2A | SOLDER | J9-C | SOLDER |
| P55NR16 | | 8.00 | RED MKG | J13-T | | GND STUD | ⑤ |
| P55NP16 | | 23.00 | RED MKG | P11-J | | GND STUD | ⑤ |
| X91E16 | | 20.25 | BLK MKG | J9-A | | P11-C | SOLDER |
| X197H16 | | 20.25 | BLK MKG | J9-B | | P11-D | SOLDER |
| D12C16 | | 20.00 | RED MKG | R219A | | J9-D | SOLDER |
| D17B16 | | 18.25 | BLK MKG | P11-A | | TB203-4 | ⑤ |
| D16B16 | 16 | 17.75 | | P11-F | | TB203-3 | ⑤ |
| D18B18 | 18 | 21.00 | | P11-H | SOLDER | Q205-GATE | SOLDER |
| D40A16 | 16 | 16.00 | | TB203-1 | ⑤ | T203-3 | SOLDER |
| D41A16 | | 16.00 | | TB203-2 | ⑤ | T203-4 | SOLDER |
| D42A16 | | 8.00 | | T203-1 | SOLDER | T201-2A | ⑤ |
| D42B16 | | 20.00 | | TB201-2A | ⑤ | R224B | SOLDER |
| D42C16 | | 14.00 | | TB201-2B | ⑤ | CR201 | SOLDER |
| D42D16 | | 17.50 | | TB201-2B | ⑤ | CR204 | SOLDER |
| D43A16 | | 18.50 | | CR207 | SOLDER | R219B | SOLDER |
| D44A16 | 16 | 15.00 | BLK MKG | E201 | ⑤ | RFI-1A | ⑥ |
| | | | | | | | |

NOTES:

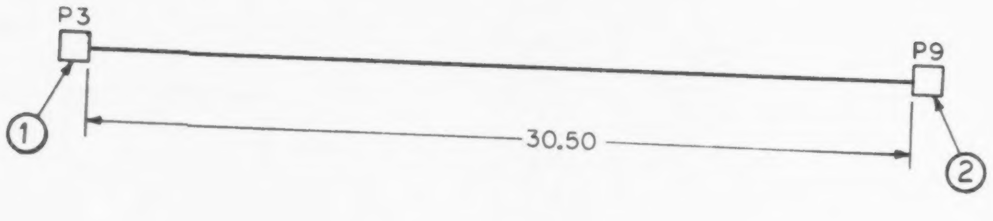
1. INTERPRET DWG PER MIL-STD-100.
2. ALL WIRE SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING STRAPS ⑩⑪. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5, OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. CUT INSULATION TUBING ⑧ IN HALF-INCH PIECES AND INSTALL AROUND WIRES AND PINS AT RECEPTACLES.
6. INSTALL NYLON FILLER PLUGS ⑫ IN UNUSED OPENINGS OF CONNECTOR PLUG BUSHING.

| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 13 | AR | WIRE, AN-18, COLOR WHITE | MIL-W-5086/2 |
| 12 | 2 | PLUG, END SEAL, ELEC CONN | |
| 11 | AR | STRAP, CABLE, ADJUSTABLE | |
| 10 | AR | STRAP, CABLE, ADJUSTABLE | |
| 9 | | | |
| 8 | AR | INSULATED SLEEVING, .125 ID, BLK | MIL-I-23053/5, CLASS 1 |
| 7 | | | |
| 6 | 4 | TERMINAL, LUG, CRIMP STYLE | |
| 5 | 36 | TERMINAL, LUG, CRIMP STYLE | |
| 4 | AR | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| 3 | 1 | CONNECTOR, RECEPT, ELEC | |
| 2 | 1 | CONNECTOR, PLUG, ELEC | |
| 1 | 1 | CONNECTOR, RECEPT, ELEC | |

LIST OF MATERIAL

ME 6115-545-34/5-24 C1

Figure 5-24. Excitation System Assembly Wiring Harness



| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 5 | AR | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| 4 | AR | STRAP, CABLE, ADJUSTABLE | |
| 3 | 4 | PLUG, END SEAL, ELEC CONN | |
| 2 | 1 | CONNECTOR, PLUG, ELEC, STR | |
| 1 | 1 | CONNECTOR, PLUG, ELEC, STR | |

LIST OF MATERIAL

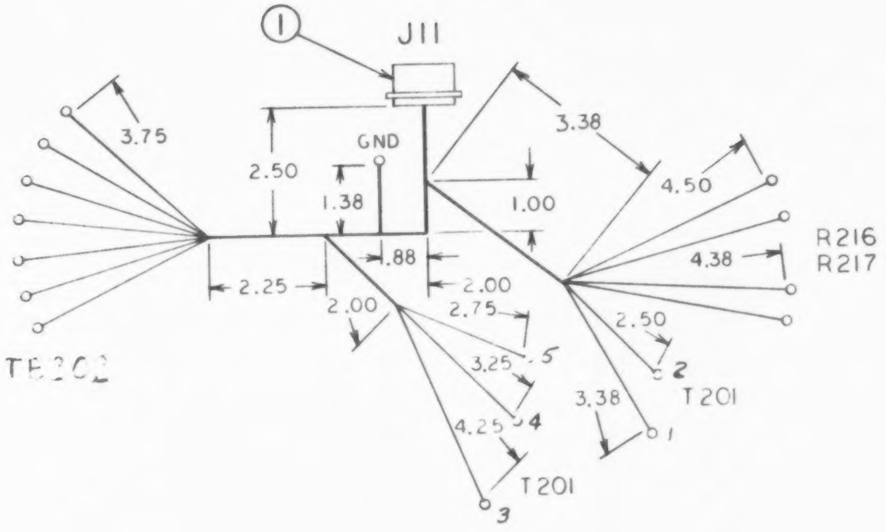
| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X197G16 | 16 | 32.00 | BLK MKG | P3-B | SOLDER | P9-B | SOLDER |
| X91D16 | ↑ | ↑ | BLK MKG | P3-A | ↑ | P9-A | ↑ |
| D11B16 | ↓ | ↓ | RED MKG | P3-C | ↓ | P9-C | ↓ |
| D12B16 | 16 | 32.00 | RED MKG | P3-D | SOLDER | P9-D | SOLDER |

NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. WIRING SHALL BE NEATLY LACED THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ④, LOCATED AT INTERVALS NOT TO EXCEED THREE INCHES BETWEEN STRAPS.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. INSTALL NYLON FILLER PLUGS ③ IN UNUSED OPENINGS OF CONNECTOR BUSHING.

ME 6115-545-34/5-25

Figure 5-25. Excitation System Assembly Interconnecting Wiring Harness



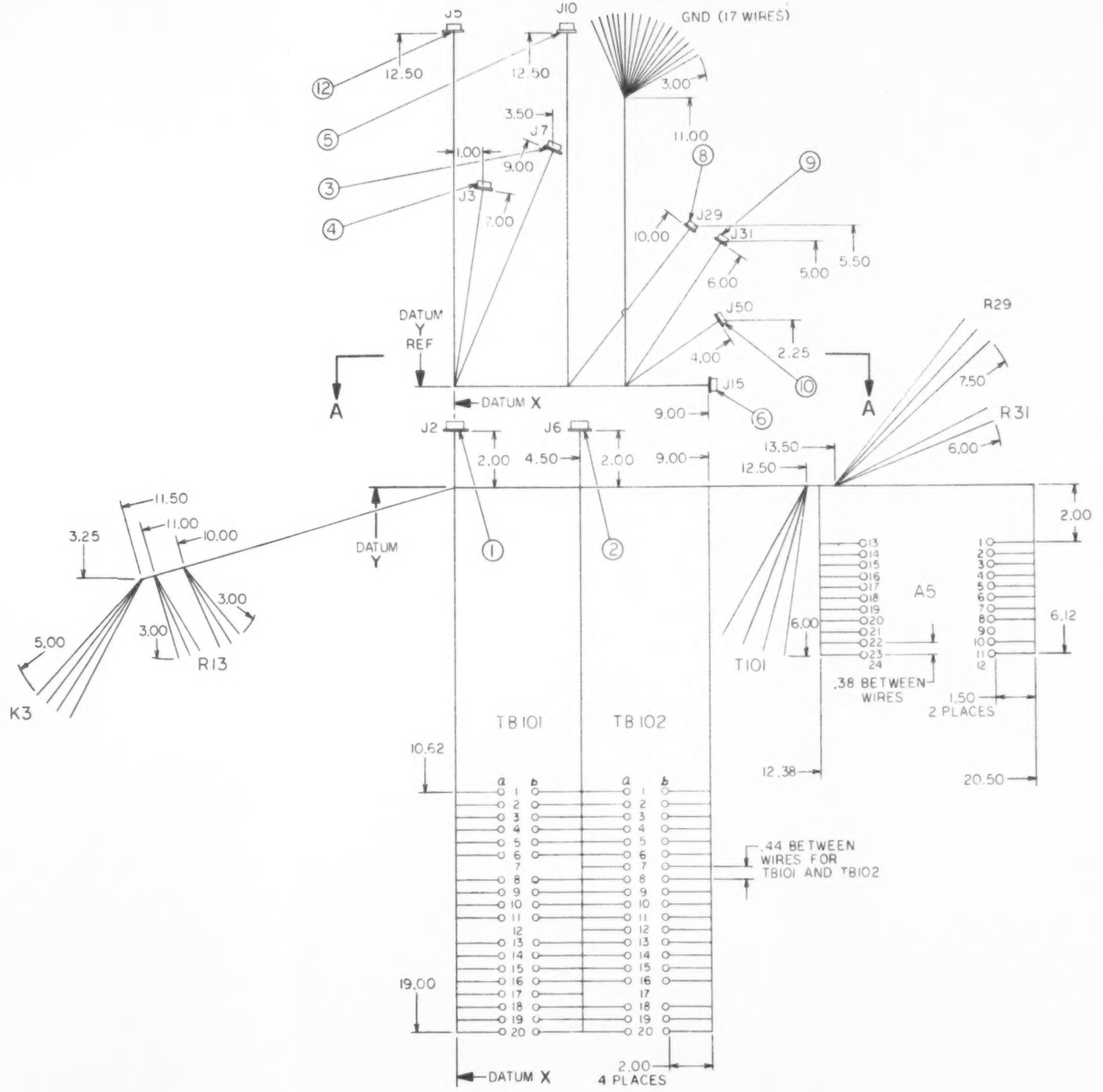
NOTES: –
1. INTERPRET DRAWING PER MIL-STD-100.
2 ALL WIRE SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ⑤⑥. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. CUT INSULATION TUBING IN HALF-INCH PIECES ⑦ AND INSTALL AROUND WIRES AND PINS AT RECEPTACLES

| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X12T16N | 16 | 10.50 | BLACK MKG | J11-A | SOLDER | TB202-4 | ③ |
| X197J16 | | 10.50 | | J11-D | | R217 | SOLDER |
| X197K16 | | 3.00 | | R217 | | R216 | |
| X197L16 | | 8.00 | | R216 | | T201-1 | SOLDER |
| 53A16 | | 10.50 | | T201-5 | | TB202-6 | ③ |
| X91F16 | | 9.75 | | J11-C | | R217 | SOLDER |
| X91G16 | | 3.00 | | R217 | | R216 | |
| X91H16 | | 7.50 | | R216 | | T201-2 | SOLDER |
| 52A16 | | 12.50 | BLACK MKG | T201-3 | | TB202-7 | ③ |
| D11G16 | | 10.50 | RED MKG | J11-E | | TB202-5 | |
| 27B16 | | 10.50 | BLACK MKG | J11-F | | TB202-3 | |
| 27C16 | | 11.00 | | T201-4 | | TB202-3 | |
| 19B16 | | 10.50 | | J11-G | | TB202-2 | |
| 22B16 | | 10.50 | BLACK MKG | J11-H | | TB202-1 | |
| P55NT16N | 16 | 5.50 | RED MKG | J11-J | SOLDER | GND | ③ |
| | | | | | | | |

| 7 | AR | INSUL, SLEEVING, .12 I.D. BLACK | MIL-I-23053/5 CLASS I |
|---|---|---|---|
| 6 | AR | STRAP, CABLE, ADJUSTABLE | |
| 5 | AR | STRAP, CABLE, ADJUSTABLE | |
| 4 | | | |
| 3 | 9 | TERMINAL, LUG, CRIMP STYLE | |
| 2 | AR | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| 1 | 1 | CONNECTOR, RECEPT, ELEC | |
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| | LIST OF MATERIAL | | |

ME 6115-545-34/5-26 C1

Figure 5-26. Voltage Regulator Wiring Harness


J5
J10
GND (17 WIRES)
⑫
12.50
12.50
⑤
3.00
11.00
3.50
J7
1.00
③
9.00
J3
④
7.00
⑧
⑨
J29
10.00
J31
6.00
5.00
5.50
DATUM
Y
REF
J50
4.00
2.25
⑩
R29
7.50
A
A
DATUM X
J15
9.00
⑥
R31
6.00
J2
J6
2.00
4.50
2.00
9.00
13.50
12.50
11.50
11.00
10.00
3.25
DATUM
Y
①
②
2.00
3.00
3.00
5.00
R13
K3
A5
13
14
15
16
17
18
19
20
21
22
23
24
1
2
3
4
5
6
7
8
9
10
11
12
6.00
6.12
T101
.38 BETWEEN WIRES
1.50
2 PLACES
TB101
TB102
10.62
12.38
20.50
a
b
.44 BETWEEN WIRES FOR TB101 AND TB102
19.00
DATUM X
2.00
4 PLACES

NOTES:
1 INTERPRET DWG PER MIL-STD-100.
2. ALL WIRES SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING STRAPS (22)(23). LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3. SOLDERING (26) SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4 WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. CUT INSULATION TUBING IN HALF-INCH PIECES AND INSTALL AROUND WIRES AND PINS AT RECEPTACLES.

| | | | |
|---|---|---|---|
| 26 | AR | SOLDER | QQ-S-571 |
| 25 | AR | WIRE, 16 AN, COLOR WHITE | MIL-W-5086/2 |
| 24 | AR | WIRE, 12 AN, COLOR WHITE | MIL-W-5086/2 |
| 23 | AR | STRAP, CABLE, ADJUSTABLE | |
| 22 | AR | STRAP, CABLE, ADJUSTABLE | |
| 21 | AR | INSUL SLEEVING .125 ID, BLACK | MIL-I-23053 CLASS 1 |
| 20 | AR | INSUL SLEEVING .187 ID, BLACK | MIL-I-23053 CLASS 1 |
| 19 | 4 | TERMINAL, LUG CRIMP STYLE | |
| 18 | 6 | | |
| 17 | 2 | | |
| 16 | 2 | | |
| 15 | 7 | | |
| 14 | 13 | | |
| 13 | 129 | TERMINAL, LUG CRIMP STYLE | |
| 12 | 1 | CONNECTOR, RECEPTACLE, ELEC | |
| 11 | | | |
| 10 | 1 | | |
| 9 | 1 | | |
| 8 | 1 | | |
| 7 | | | |
| 6 | 1 | | |
| 5 | 1 | | |
| 4 | 1 | | |
| 3 | 1 | | |
| 2 | 1 | | |
| 1 | 1 | CONNECTOR, RECEPTACLE ELEC | |
| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |

LIST OF MATERIAL

ME 6115-545-34/5-27(1) C1

**Figure 5-27. Set Special Relay Assembly (Class 1, Mode I) Sets, Wiring Harness (Sheet 1 of 5)**

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| P4OK16 | 16 | 14.25 | RED MKG | J2-U | SOLDER | TB101-1a | ⑬ |
| P4OJ16 | ↑ | 14.25 | ↑ | J2-V | SOLDER | TB101-2a | ↑ |
| P4CB16 | | 20.00 | | J5-M | SOLDER | TB101-1b | |
| P40F16 | | 31.50 | | A5-1 | ⑬ | TB101-2b | ↓ |
| P4OD16 | | 20.75 | | J29-A | SOLDER | TB101-1a | ⑬ |
| P198C16 | | 10.50 | | J2-c | ↑ | J5-G | SOLDER |
| P199C16 | | 17.75 | | J2-a | | J10-b | SOLDER |
| P50J16 | | 15.00 | | J2-w | | TB101-3a | ⑬ |
| P5CR16 | | 20.50 | | J50-B | ↓ | TB101-4a | ↑ |
| P50P16 | | 20.50 | | J50-L | SOLDER | TB101-5a | |
| P50Y16 | | 18.00 | | J31-E | ⑬ | TB101-4a | |
| P50N16 | | 24.75 | | J10-c | SOLDER | TB101-3b | |
| P50S16 | | 23.50 | | J10a | ↑ | TB101-3b | |
| P50T16 | | 21.00 | | J5k | | TB101-4b | |
| P50M16 | | 21.00 | | J5c | ↓ | TB101-4b | |
| P50K16 | | 22.25 | | J5-e | SOLDER | TB101-5a | |
| P50L16 | | 24.00 | | A5-21 | ⑬ | TB101-5b | |
| P80C16 | | 15.75 | | J2-m | SOLDER | TB101-6a | |
| P80B16 | | 22.75 | | J5-p | ↑ | TB101-6a | |
| P80M16 | | 21.50 | | J5-P | | TB101-6b | |
| P80L16 | | 21.25 | | J5-R | ↓ | TB101-6b | |
| P57E16 | | 17.25 | | J2-± | SOLDER | TB101-8a | |
| P57F16 | | 20.00 | | J31-L | ⑬ | TB101-8b | |
| | | | | | | | |
| P47G16 | | 17.00 | | J2-e | SOLDER | TB101-9a | |
| P47F16 | | 23.25 | | J5-n | SOLDER | TB101-9b | |
| P47H16 | | 24.75 | | J29-F | SOLDER | TB101-9a | |
| P47E16 | | 29.75 | | A5-16 | ⑬ | TB101-9b | |
| P44D16 | | 18.50 | | J2-g | SOLDER | TB101-10a | |
| P44E16 | | 23.00 | | J5-D | ↑ | TB101-10b | |
| P44G16 | | 25.00 | | J29-G | | TB101-10a | |
| P45G16 | | 19.00 | | J2-R | | TB101-11a | |
| P45J16 | | 20.75 | | J6-A | | TB101-11b | ↓ |
| P45H16 | | 25.25 | | J29-D | | TB101-11a | ⑬ |
| P46C16 | | 11.50 | | J2-x | | J5-H | SOLDER |
| P62B16 | | 23.00 | | J2-h | | TB101-20a | ⑬ |
| P55G16N | | 19.00 | | J2-p | | GNDSTUD | ⑭ |
| P55J16N | | 15.00 | | J50-M | | ↑ | ↑ |
| P55LL16N | ↓ | 13.75 | | J5-h | | | ↓ |
| P55RI6N | 16 | 12.25 | | J54-D | | | ⑭ |
| P55Z12N | 12 | 26.25 | | J31-D | | | ⑮ |
| P55BI6N | 16 | 14.50 | | J58 | ↓ | | ⑭ |
| P55TI6N | ↑ | 25.50 | | J5S | SOLDER | | ↑ |
| P55C16N | ↓ | 26.00 | | A5-15 | ⑬ | | ↓ |
| P55PPI6N | 16 | 21.00 | | J31-Z | ⑬ | | ⑭ |
| P55D12N | 12 | 11.00 | | J7-A | SOLDER | | ⑮ |
| | | | | | ↑ | | |
| P55P16N | 16 | 11.50 | | J29-E | ↓ | | ⑭ |
| P55VV16N | 16 | 18.25 | | J2-r | SOLDER | ↓ | ⑬ |
| P55F16N | 16 | 33.50 | | K3-XP | ⑯ | GNDSTUD | ⑬ |
| P140B12 | 12 | 22.25 | | J5-w | SOLDER | R13-1 | ⑮ |
| P14A12 | 12 | 23.00 | | R13-2 | ⑮ | J5z | SOLDER |
| P141B12 | 12 | 20.75 | | R13-2 | ⑮ | J7-E | SOLDER |
| P48B16 | 16 | 34.75 | ↓ | J5-U | SOLDER | A5-12 | ⑬ |
| P54B16 | 16 | 23.50 | RED MKG | J5-V | SOLDER | A5-13 | ⑬ |

ME 6115-545-34/5-27(2)

Figure 5-27. Set Special Relay Assembly (Class 1, Mode I) Sets. Wiring Harness (Sheet 2 of 5)

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| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| P56D16 | 16 | 19.00 | RED MKG | J2-k | SOLDER | TB101-13a | ⑬ |
| P56E16 | | 26.75 | | J29-H | | TB101-13a | ⑬ |
| P56H16 | | 29.00 | | J10-d | | TB101-13b | ⑬ |
| | | | | | | | |
| P58C16 | | 21.00 | | J5-E | | J50-A | SOLDER |
| P52B16 | | 31.75 | | J5-Y | | A5-4 | ⑬ |
| P60A16 | | 32.00 | | J50-E | | J31-H | ⑬ |
| P63C16 | | 40.00 | | J50-a | | J10-U | SOLDER |
| | | | | | | | |
| P200B16 | | 24.75 | | J6-C | | TB102-20a | ⑬ |
| P200E16 | | 33.25 | | J5-m | | TB102-19b | |
| P200C16 | | 33.00 | | J5-W | | TB102-20b | |
| P200D16 | | 32.00 | | J5-Z | | TB102-19a | |
| P200K16 | | 24.00 | | J50-P | SOLDER | TB102-20b | |
| P200L16 | | 25.00 | | K12-6 | ⑬ | TB102-19a | |
| P200J16 | | 40.50 | | A5-5 | ⑬ | TB102-19b | ⑬ |
| P201B16 | | 14.00 | | J5-C | SOLDER | J6-D | SOLDER |
| P202B16 | | 14.50 | | J5-B | SOLDER | J6-E | |
| P203B16 | | 6.50 | | J50-F | SOLDER | J6-F | |
| P204B16 | | 20.00 | | J31-F | ⑬ | J6-G | |
| P205B16 | | 6.50 | | J50-D | SOLDER | J6-H | |
| P206B16 | | 7.00 | | J50-C | SOLDER | J6-I | |
| P207B16 | | 14.50 | | J5-A | SOLDER | J6-K | |
| P208B16 | | 15.25 | | A5-17 | ⑬ | J6-L | |
| P209B16 | | 7.00 | | J50-G | SOLDER | J6-M | |
| P210B16 | | 19.00 | | J31-V | ⑬ | J6-N | SOLDER |
| P66A16 | | 25.00 | | J6-B | SOLDER | A5-3 | ⑬ |
| | | | | | | | |
| P68A16 | | 33.25 | | J5-b | | A5-6 | ⑬ |
| P81B16 | | 18.00 | | J5-F | SOLDER | J31-C | SOLDER |
| P49A16 | | 40.50 | | K3-XI | ⑯ | A5-10 | ⑬ |
| E37C16 | | 11.75 | | J2-X | SOLDER | J5-K | SOLDER |
| E38C16 | | 10.50 | | J2-W | | J5-J | SOLDER |
| E39C16 | | 10.75 | | J2-V | | J5-I | SOLDER |
| E36C16 | | 15.00 | | J2-Z | | R-13-3 | ⑱ |
| E35C16 | 16 | 14.00 | | J2-Y | | R-13-4 | ⑱ |
| V65B12 | 12 | 27.50 | | J7-D | | TB101-18a | ⑲ |
| V64B12 | 12 | 28.50 | | J7-C | SOLDER | TB101-19a | ⑲ |
| D12A16 | 16 | 17.00 | | A5-14 | ⑬ | J3-D | SOLDER |
| D11A16 | | 24.00 | | A5-2 | ⑬ | J3-C | SOLDER |
| P51B16 | | 32.50 | | J5-r | SOLDER | TB102-18b | ⑬ |
| P51D16 | | 31.00 | | J5-f | SOLDER | TB102-18a | |
| P51E16 | | 35.00 | | A5-23 | ⑬ | TB102-18a | |
| P51A16 | | 26.50 | RED MKG | J7-B | SOLDER | TB102-18b | ⑬ |
| X91C16 | | 9.75 | BLK MKG | J2-L | | J3A | SOLDER |
| X29C16 | | 12.00 | BLK MKG | J2-S | | J29-B | SOLDER |
| X31C16 | | 11.50 | | J2-O | SOLDER | J29-C | SOLDER |
| X9Z16 | | 26.00 | | A5-18 | ⑬ | TB102-1a | ⑬ |
| X9C16C | | 17.00 | | J2-z | SOLDER | TB102-1b | |
| X9A16C | | 23.00 | | J10-e | | TB102-1a | |
| X9ZZ16C | | 14.25 | | J50-J | | TB102-2b | |
| X9L16C | | 18.00 | | J31-A | | TB102-2a | |
| X12C16N | | 18.00 | | J2-y | | TB102-3b | |
| X12B16N | | 23.00 | | J10f | | TB102-3a | |
| X12N16N | 16 | 16.75 | BLK MKG | J50-K | SOLDER | TB102-4a | ⑬ |

ME 6115-545-34/5-27(3)

Figure 5-27. Set Special Relay Assembly (Class 1, Mode I) Sets, Wiring Harness (Sheet 3 of 5)

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X12W16N | 16 | 19.75 | BLK MKG | J31-B | SOLDER | TB102-4b | ⑬ |
| X8E16B | ↑ | 19.50 | ↑ ↑ | J2-F | ↑ | TB102-5b | ↑ |
| X8B16B | | 24.00 | | J10-F | | TB102-5a | |
| X8Z16B | | 17.00 | | J50-R | | TB102-5b | |
| X7C16A | | 20.25 | | J2-E | | TB102-6b | |
| X7A16A | | 24.00 | | J10-E | | TB102-6a | |
| X7Z16A | | 14.50 | | J50-S | | TB102-6b | |
| X14C16 | | 20.25 | | J2-G | | TB102-7b | |
| X14B16 | | 25.50 | | J10-G | | TB102-7a | |
| X15H16 | | 21.50 | | J31-R | | TB102-8b | |
| X15C16 | | 21.50 | | J2-H | | TB102-8b | |
| X15B16 | | 25.50 | | J10-H | | TB102-8a | |
| X16C16 | | 22.25 | | J2-1 | | TB102-9b | |
| X16B16 | | 25.50 | | J10-L | | TB102-9a | |
| X17C16 | | 26.25 | | J10-D | | TB102-10a | |
| X17D16 | | 20.00 | | J50-T | | TB102-10b | |
| X18C16 | | 26.50 | | J10-J | | TB102-11a | |
| X18D16 | | 19.50 | | J50-U | | TB102-11b | |
| X19C16 | | 27.75 | | J10-K | | TB102-12a | |
| X19D16 | | 20.00 | | J50-V | | TB102-12b | ↓ |
| X6D16 | | 25.75 | | J10-g | | A5-22 | ⑬ |
| L93D16 | | 12.25 | | J2-b | | J31-P | SOLDER |
| X195C16 | | 23.25 | | J2-f | ↓ | TB102-13b | ⑬ |
| X195D16 | | 29.50 | | J10-V | SOLDER | TB102-13b | ↑ |
| X197F16 | | 31.50 | | T101-3 | ⑱ | TB102-14a | |
| X197C16 | | 23.75 | | J2-n | SOLDER | TB102-14b | |
| X197D16 | | 25.00 | | J3-B | ↑ | TB102-14b | ↓ |
| X197E16 | | 33.75 | | R31-1 | | TB102-14a | ⑬ |
| X97A16 | | 27.75 | | J10-M | | R29-C | SOLDER |
| X90F16 | | 24.50 | | J2-U | ↓ | TB102-15b | ⑬ |
| X90D16 | | 34.00 | | R31-2 | SOLDER | TB102-15a | ↑ |
| X90E16 | | 31.75 | | T101-4 | ⑱ | TB102-15a | |
| X195E16 | | 33.50 | | R-29-1 | SOLDER | TB102-13b | |
| X194C16 | | 25.00 | | J2-P | ↑ | TB102-16b | |
| X194E16 | | 30.00 | | J10-W | | TB102-16b | ↓ |
| X194D16 | | 35.75 | | R29-2 | | TB102-16a | ⑬ |
| D20C16 | | 17.75 | | J2-A | | J10-A | SOLDER |
| D21C16 | | 17.50 | | J2-B | | J10-B | SOLDER |
| D22C16 | | 18.00 | | J2-C | | J10-C | ↑ |
| D24C16 | | 10.00 | | J2-D | | J50-d | |
| K32C16 | | 12.25 | | J2-M | | J31-M | |
| K33C16 | | 12.50 | | J2-N | | J31-N | |
| K34C16 | | 13.00 | | J2-T | | J31-T | |
| K101F16 | | 8.00 | | J31-U | | J50-X | |
| K102F16 | | 7.50 | | J31-S | | J50-N | ↓ |
| K110F16 | | 9.50 | | J31-G | | J10-h | SOLDER |
| K111D16 | | 26.50 | | J31-J | | TB101-14b | ⑬ |
| K111E16 | | 24.50 | | J15-C | | TB101-14a | ↑ |
| K111F16 | | 24.75 | | J15-G | | TB101-14a | |
| K111G16 | | 23.50 | | J15-L | | TB101-14b | |
| K112G16 | ↓ | 30.00 | ↓ ↓ | J10-j | ↓ | TB101-15b | ↓ |
| K112A16 | 16 | 24.50 | BLK MKG | J15-D | SOLDER | TB101-15b | ⑬ |

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Figure 5-27. Set Special Relay Assembly (Class 1, Mode I) Sets, Wiring Harness (Sheet 4 of 5)

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| K112B16 | 16 | 24.50 | BLK MKG | J15-H | SOLDER | TB101-15a | ⑬ |
| K112C16 | | 23.50 | | J15-M | | TB101-15b | |
| L26C16 | | 27.50 | | J2-K | | A5-8 | |
| L25C16 | | 20.00 | | J2-J | | A5-19 | |
| X21T16 | | 25.25 | | J10-X | | A5-20 | |
| X22T16 | | 31.25 | | J10-Y | | A5-7 | |
| X98N16 | | 31.00 | | J10-N | | TB101-16b | |
| X98H16 | | 25.50 | | J15-B | | TB101-16a | |
| X98J16 | | 24.50 | | J15-F | | TB101-16a | |
| X98K16 | | 23.75 | | J15-K | SOLDER | TB101-16b | |
| X96A16 | | 32.75 | | T101-2 | ⑱ | TB101-17b | |
| X96B16 | | 26.00 | | J15-A | SOLDER | TB101-17a | |
| X96C16 | | 25.50 | | J15-E | SOLDER | TB101-17a | |
| X96D16 | 16 | 25.00 | | J15-J | SOLDER | TB101-17b | |
| X195F16 | 16 | 31.25 | BLK MKG | T101-1 | ⑱ | TB102-13a | ⑬ |
| V65C12 | 12 | 28.50 | RED MKG | J5-x | SOLDER | TB101-18b | ⑲ |
| V64C12 | 12 | 29.00 | | J5-y | | TB101-19b | ⑲ |
| P55AB16N | | 15.00 | | J50-W | | GND STUD | ⑭ |
| P62A16 | | 27.50 | | J50-H | | TB101-20a | ⑬ |
| P62E16 | | 27.25 | RED MKG | J50-b | | TB101-20b | ⑬ |
| X9YY16C | | 17.00 | BLK MKG | J15-S | | TB102-2b | ⑬ |
| X12BB16N | 16 | 16.50 | BLK MKG | J15-P | | TB102-3b | ⑬ |
| P55M12N | 12 | 19.25 | RED MKG | J10-O | | GND STUD | ⑮ |
| P55CR16N | 16 | 19.50 | | J10-Z | SOLDER | GND STUD | ⑭ |
| P140D12 | 12 | 6.00 | | R13-1 | ⑮ | K3-1 | ⑰ |
| P142A12 | 12 | 26.50 | RED MKG | J5-y | SOLDER | K3-2 | ⑰ |

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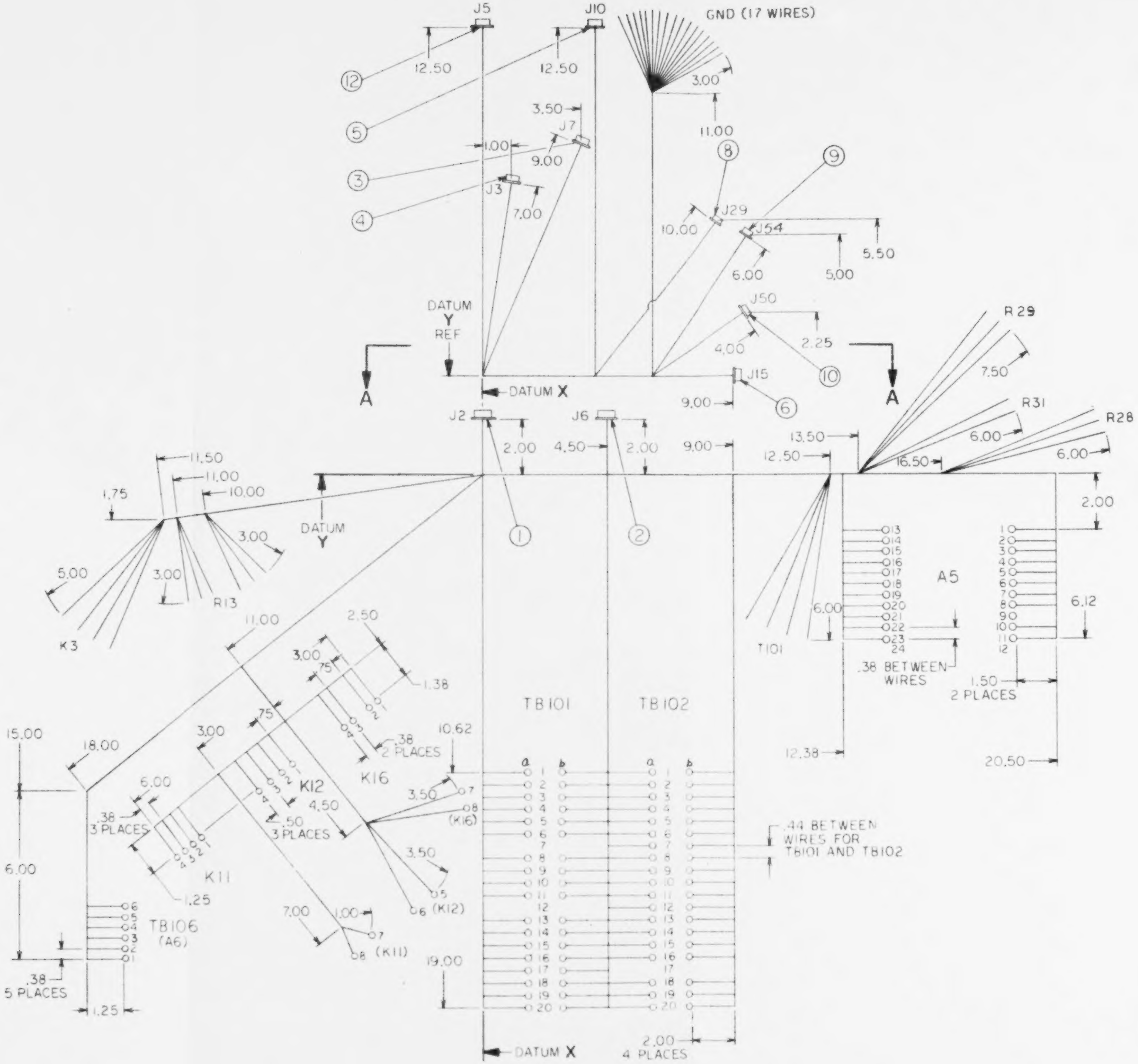
Figure 5-27. Set Special Relay Assembly (Class 1, Mode I) Sets, Wiring Harness (Sheet 5 of 5)



J5
J10
GND (17 WIRES)
12.50
12.50
3.00
⑫
⑤
3.50
J7
11.00
1.00
9.00
③
J3
⑧
⑨
④
7.00
J29
10.00
J54
5.50
6.00
5.00
DATUM
Y
REF
J50
2.25
4.00
⑩
A
DATUM X
J15
9.00
⑥
A
R29
7.50
R31
R28
6.00
6.00
J2
J6
2.00
4.50
2.00
9.00
13.50
12.50
16.50
11.50
11.00
10.00
1.75
DATUM
Y
①
②
2.00
3.00
5.00
3.00
R13
K3
11.00
2.50
3.00
.75
1.38
A5
6.00
6.12
T101
.38 BETWEEN WIRES
1.50
2 PLACES
12.38
20.50
TB101
TB102
.38
2 PLACES
K16
10.62
3.00
.75
K12
15.00
18.00
6.00
.38
3 PLACES
.50
3 PLACES
4.50
3.50
(K16)
K11
1.25
3.50
(K12)
6.00
7.00
1.00
(K11)
TB106
(A6)
19.00
.38
5 PLACES
1.25
.44 BETWEEN WIRES FOR TB101 AND TB102
2.00
4 PLACES
DATUM X

NOTES:

1. INTERPRET DWG PER MIL-STD-100.
2. ALL WIRES SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING STRAPS (22)(23). LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAKOUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3. SOLDERING (26) SHALL BE DONE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. CUT INSULATION TUBING IN HALF-INCH PIECES AND INSTALL AROUND WIRES AND PINS AT RECEPTACLES.

| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 26 | AR | SOLDER | QQ-S-571 |
| 25 | AR | WIRE, 16AN, COLOR WHITE | MIL-W-5086/2 |
| 24 | AR | WIRE, 12AN, COLOR WHITE | MIL-W-5086/2 |
| 23 | AR | STRAP, CABLE, ADJUSTABLE | |
| 22 | AR | STRAP, CABLE, ADJUSTABLE | |
| 21 | AR | INSUL, SLEEVING .125ID, BLACK | MIL-I-23053 CLASS I |
| 20 | AR | INSUL, SLEEVING .187ID, BLACK | MIL-I-23053 CLASS I |
| 19 | 4 | TERMINAL, LUG CRIMP STYLE | |
| 18 | 9 | ↕ | |
| 17 | 2 | ↕ | |
| 16 | 2 | ↕ | |
| 15 | 8 | ↕ | |
| 14 | 14 | ↕ | |
| 13 | 159 | TERMINAL, LUG CRIMP STYLE | |
| 12 | 1 | CONNECTOR, RECEPTACLE, ELEC | |
| 11 | | ↕ | |
| 10 | 1 | ↕ | |
| 9 | 1 | ↕ | |
| 8 | 1 | ↕ | |
| 7 | | ↕ | |
| 6 | 1 | ↕ | |
| 5 | 1 | ↕ | |
| 4 | 1 | ↕ | |
| 3 | 1 | ↕ | |
| 2 | 1 | ↕ | |
| 1 | 1 | CONNECTOR, RECEPTACLE ELEC | |

LIST OF MATERIAL

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Figure 5-28. Set Special Relay Assembly (Class 1, Mode II) Sets, Wiring Harness (Sheet 1 of 5)

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| P40K16 | 16 | 14.25 | RED MKG | J2-U | SOLDER | TB101-1a | ⑬ |
| P40J16 | ↑ | 14.25 | ↑ ↑ | J2-V | SOLDER | TB101-2a | ↑ |
| P40B16 |  | 20.00 |  | J5-M | SOLDER | TB101-1b |  |
| P40F16 |  | 31.50 |  | A5-1 | ⑬ | TB101-2b | ↓ |
| P40D16 |  | 20.75 |  | J29-A | SOLDER | TB101-1a | ⑬ |
| P198C16 |  | 10.50 |  | J2-c | ↑ | J5-G | SOLDER |
| P199c16 |  | 17.75 |  | J2-a |  | J10-b | SOLDER |
| P50J16 |  | 15.00 |  | J2-w |  | TB101-3a | ⑬ |
| P50R16 |  | 20.50 |  | J50-B |  | TB101-4a | ↑ |
| P50P16 |  | 20.50 |  | J50-L |  | TB101-5a |  |
| P50Y16 |  | 22.00 |  | K16-3 |  | TB101-4a |  |
| P50N16 |  | 24.75 |  | J10-c |  | TB101-3b |  |
| P50S16 |  | 23.50 |  | J10a |  | TB101-3b |  |
| P50T16 |  | 21.00 |  | J5k |  | TB101-4b |  |
| P50M16 |  | 21.00 |  | J5c | ↓ | TB101-4b |  |
| P50K16 |  | 22.25 |  | J5-e | SOLDER | TB101-5a |  |
| P50L16 |  | 29.00 |  | A5-21 | ⑬ | TB101-5b |  |
| P80C16 |  | 15.75 |  | J2-m | SOLDER | TB101-6a |  |
| P80B16 |  | 22.75 |  | J5-p | ↑ | TB101-6a |  |
| P80M16 |  | 21.50 |  | J5-P |  | TB101-6b |  |
| P80L16 |  | 21.25 |  | J5-R |  | TB101-6b |  |
| P57E16 |  | 17.25 |  | J2-t |  | TB101-8a |  |
| P57F16 |  | 23.00 |  | K16-8 |  | TB101-8a |  |
|  |  |  |  |  |  |  |  |
| P47G16 |  | 17.00 |  | J2-e |  | TB101-9a |  |
| P47F16 |  | 23.25 |  | J5-n | ↓ | TB101-9b |  |
| P47H16 |  | 24.75 |  | J29-F | SOLDER | TB101-9a |  |
| P47E16 |  | 29.75 |  | A5-16 | ⑬ | TB101-9b |  |
| P44D16 |  | 18.50 |  | J2-g | SOLDER | TB101-10a |  |
| P44E16 |  | 23.00 |  | J5-D | ↑ | TB101-10b |  |
| P44G16 |  | 25.00 |  | J29-G |  | TB101-10a |  |
| P45G16 |  | 19.00 |  | J2-R |  | TB101-11a |  |
| P45J16 |  | 20.75 |  | J6-A |  | TB101-11b | ↓ |
| P45H16 |  | 25.25 |  | J29-D |  | TB101-11a | ⑬ |
| P46C16 |  | 11.50 |  | J2-x |  | J5-H | SOLDER |
| P62B16 |  | 23.00 |  | J2-h |  | TB101-20a | ⑬ |
| P55G16N |  | 19.00 |  | J2-p |  | GNDSTUD | ⑭ |
| P55J16N |  | 15.00 |  | J50-M |  | ↑ | ↑ |
| P55LL16N | ↓ | 13.75 |  | J5-h |  |  | ↓ |
| P55R16N | 16 | 12.25 |  | J54-D |  |  | ⑭ |
| P55Z12N | 12 | 26.25 |  | J5t |  |  | ⑮ |
| P55B16N | 16 | 14.50 |  | J5g | ↓ |  | ⑭ |
| P55T16N | ↑ | 25.50 |  | J5S | SOLDER |  | ⑭ |
| P55C16N | ↓ | 26.00 |  | A5-15 | ⑬ |  |  |
| P55PP16N | 16 | 11.50 |  | K16-4 | SOLDER |  | ⑭ |
| P55D12N | 12 | 11.00 |  | J7-A | SOLDER |  | ⑮ |
|  |  |  |  |  |  |  |  |
| P55P16N | 16 | 11.50 |  | J29-E | SOLDER |  | ⑭ |
| P55VV16N | 16 | 18.25 |  | J2-r | SOLDER | ↓ | ⑭ |
| P55F16N | 16 | 33.50 |  | K3-X2 | ⑯ | GNDSTUD | ⑭ |
| P140B12 | 12 | 22.25 |  | J5-w | SOLDER | R13-1 | ⑮ |
| P141A12 | 12 | 23.00 |  | R13-2 | ⑮ | J5-z | SOLDER |
| P141B12 | 12 | 20.75 |  | R13-2 | ⑮ | J7-E | SOLDER |
| P48B16 | 16 | 34.75 | ↓ ↓ | J5-U | SOLDER | A5-12 | ⑬ |
| P54B16 | 16 | 23.50 | RED MKG | J5-V | SOLDER | A5-13 | ⑬ |

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Figure 5-28. Set Special Relay Assembly (Class 1, Mode II) Sets, Wiring Harness (Sheet 2 of 5)

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| P56D16 | 16 | 19.00 | RED MKG | J2-k | SOLDER | TB101-13a | ⑬ |
| P56E16 | ↑ | 26.75 | ↑ | J29-H | ↑ | TB101-13a | ⑬ |
| P56H16 | | 29.00 | | J10-d | | TB101-13b | ⑬ |
| | | | | | | | |
| P58C16 | | 21.00 | | J5-E | | J50-A | SOLDER |
| P52B16 | | 31.75 | | J5-Y | | A5-4 | ⑬ |
| P60A16 | | 7.50 | | J50-E | | K11-7 | SOLDER |
| P63C16 | | 40.00 | | J50-a | | J10-U | SOLDER |
| | | | | | | | |
| P200B16 | | 24.25 | | J6-C | | TB102-20a | ⑬ |
| P200E16 | | 33.25 | | J5-m | | TB102-19b | ↑ |
| P200C16 | | 33.00 | | J5-W | | TB102-20b | |
| P200D16 | | 32.00 | | J5-Z | | TB102-19a | |
| P200K16 | | 24.00 | | J50-P | ↓ | TB102-20b | |
| P200L16 | | 27.50 | | K12-6 | SOLDER | TB102-19b | ↓ |
| P200J16 | | 40.50 | | A5-5 | ⑬ | TB102-19a | ⑬ |
| P201B16 | | 14.00 | | J5-C | SOLDER | J6-D | SOLDER |
| P202B16 | | 14.50 | | J5-B | ↑ | J6-E | ↑ |
| P203B16 | | 6.50 | | J50-F | | J6-F | |
| P204B16 | | 8.50 | | K11-3 | | J6-G | |
| P205B16 | | 6.50 | | J50-D | | J6-H | |
| P206B16 | | 7.00 | | J50-C | ↓ | J6-I | |
| P207B16 | | 14.50 | | J5-A | SOLDER | J6-K | |
| P208B16 | | 15.25 | | A5-17 | ⑬ | J6-L | |
| P209B16 | | 7.00 | | J50-G | SOLDER | J6-M | ↓ |
| P210B16 | | 9.50 | | K12-5 | ↑ | J6-N | SOLDER |
| P66A16 | | 25.00 | | J6-B | | A5-3 | ⑬ |
| | | | | | | | |
| P68A16 | | 33.25 | | J5-b | ↓ | A5-6 | ⑬ |
| P81B16 | | 18.00 | | J5-F | SOLDER | J54-C | SOLDER |
| P49A16 | | 40.50 | | K3-XI | ⑯ | A5-10 | ⑬ |
| E37C16 | | 11.75 | | J2-X | SOLDER | J5-K | SOLDER |
| E38C16 | | 10.50 | | J2-W | ↑ | J5-J | SOLDER |
| E39C16 | | 10.75 | | J2-V | | J5-I | SOLDER |
| E36C16 | ↓ | 15.00 | | J2-Z | | R-13-3 | ⑱ |
| E35C16 | 16 | 14.00 | | J2-Y | | R-13-4 | ⑱ |
| V65B12 | 12 | 27.50 | | J7-D | ↓ | TB101-18a | ⑲ |
| V64B12 | 12 | 28.50 | | J7-C | SOLDER | TB101-19a | ⑲ |
| D12A16 | 16 | 17.00 | | A5-14 | ⑬ | J3-D | SOLDER |
| D11A16 | ↑ | 24.00 | | A5-2 | ⑬ | J3-C | SOLDER |
| P51B16 | | 32.50 | | J5-r | SOLDER | TB102-18b | ⑬ |
| P51D16 | | 31.00 | | J5-f | SOLDER | TB102-18a | ↑ |
| P51E16 | | 35.00 | ↓ | A5-23 | ⑬ | TB102-18a | ↓ |
| P51A16 | | 26.50 | RED MKG | J7-B | SOLDER | TB102-18b | ⑬ |
| X91C16 | | 9.75 | BLK MKG | J2-L | ↑ | J3A | SOLDER |
| X29C16 | | 12.00 | BLK MKG | J2-S | ↓ | J29-B | SOLDER |
| X31C16 | | 11.50 | ↑ | J2-O | SOLDER | J29-C | SOLDER |
| X9Z16 | | 26.00 | | A5-18 | ⑬ | TB102-1a | ⑬ |
| X9C16C | | 17.00 | | J2-z | SOLDER | TB102-1a | ↑ |
| X9A16C | | 23.00 | | J10-e | ↑ | TB102-1b | |
| X9ZZ16C | | 14.25 | | J50-J | | TB102-2b | |
| X9L16C | | 18.00 | | J54-A | | TB102-2a | |
| X12C16N | | 18.00 | | J2-Y | | TB102-3b | |
| X12B16N | ↓ | 23.00 | ↓ | J10f | ↓ | TB102-3a | ↓ |
| X12N16N | 16 | 16.75 | BLK MKG | J50-K | SOLDER | TB102-4a | ⑬ |

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Figure 5-28. Set Special Relay Assembly (Class 1, Mode II) Sets, Wiring Harness (Sheet 3 of 5)

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X12W16N | 16 | 19.75 | BLK MKG | J54-B | SOLDER | TB102-4b | ⑬ |
| X8E16B | ↑ | 19.50 | ↑ ↑ | J2-F | ↑ | TB102-5b | ↑ |
| X8B16B | | 24.00 | | J10-F | | TB102-5a | |
| X8ZZ16B | | 17.00 | | J50-R | | TB102-5b | |
| X7C16A | | 20.25 | | J2-E | | TB102-6b | |
| X7A16A | | 24.00 | | J10-E | | TB102-6a | |
| X7ZZ16A | | 14.50 | | J50-S | | TB102-6b | |
| X14C16 | | 20.25 | | J2-G | ↓ | TB102-7b | |
| X14B16 | | 25.50 | | J10-G | SOLDER | TB102-7a | |
| X15H16 | | 20.00 | | K16-2 | ⑬ | TB102-8b | |
| X15C16 | | 21.50 | | J2-H | SOLDER | TB1028b | |
| X15B16 | | 25.50 | | J10-H | ↑ | TB102-8a | |
| X16C16 | | 22.25 | | J2-1 | | TB102-9b | |
| X16B16 | | 25.50 | | J10-L | | TB102-9a | |
| X17C16 | | 26.25 | | J10-D | | TB102-10a | |
| X17D16 | | 20.00 | | J50-T | | TB102-10b | |
| X18C16 | | 26.50 | | J10-J | | TB102 11a | |
| X18D16 | | 19.50 | | J50-U | | TB102-11b | |
| X19C16 | | 27.75 | | J10-k | | TB102-12a | |
| X19D16 | | 20.00 | | J50-V | | TB102-12b | |
| X6D16 | | 25.75 | | J10-g | | A5-22 | |
| L93D16 | | 22.00 | | J 2-b | | K16-1 | |
| X195C16 | | 23.25 | | J2-f | ↓ | TB102-13b | |
| X195D16 | | 29.25 | | J10-V | SOLDER | TB102-13b | |
| X197F16 | | 31.50 | | T101-3 | ⑱ | TB102-14a | |
| X197C16 | | 23.75 | | J2-n | SOLDER | TB102-14b | |
| X197D16 | | 25.00 | | J3-B | ↑ | TB102-14b | ↓ |
| X197E16 | | 33.75 | | R31-1 | | TB102-14a | ⑬ |
| X97A16 | | 27.75 | | J10-M | | R29-C | SOLDER |
| X90F16 | | 24.50 | | J2-U | ↓ | TB102-15b | ⑬ |
| X90D16 | | 34.00 | | R31-2 | SOLDER | TB102-15a | ↑ |
| X90E16 | | 31.75 | | T101-4 | ⑱ | TB102-15a | |
| X195E16 | | 33.50 | | R-29-1 | SOLDER | TB102-13a | |
| X194C16 | | 25.00 | | J2-P | ↑ | TB102-16b | |
| X194E16 | | 30.00 | | J10-W | | TB102-16b | ↓ |
| X194D16 | | 35.75 | | R29-2 | | TB102-16a | ⑬ |
| D20C16 | | 17.75 | | J2-A | | J10-A | SOLDER |
| D21C16 | | 17.50 | | J2-B | | J10-B | SOLDER |
| D22C16 | | 18.00 | | J2-C | | J10-C | ↑ |
| D24C16 | | 10.00 | | J2-D | | J50d | ↓ |
| K32C16 | | 12.25 | | J2-M | | J54-M | SOLDER |
| K33C16 | | 35.00 | | J2-N | | TB106-2 | ⑬ |
| K34C16 | | 37.00 | | J2-T | | TB106-4 | ⑬ |
| K101F16 | | 8.00 | | J54-U | | J50-X | SOLDER |
| K102F16 | | 7.50 | | J54-S | | J50-N | SOLDER |
| K110F16 | | 9.50 | | J54-G | | J10-h | SOLDER |
| K111D16 | | 26.00 | | J54-J | | TB101-14b | ⑬ |
| K111E16 | | 24.50 | | J15-C | | TB101-14a | ↑ |
| K111F16 | | 24.75 | | J15-G | | TB101-14a | |
| K111G16 | | 23.50 | | J15-L | | TB101-14b | |
| K112G16 | ↓ | 30.00 | ↓ ↓ | J10-j | ↓ | TB101-15b | ↓ |
| K112A16 | 16 | 24.50 | BLK MKG | J15-D | SOLDER | TB101-15a | ⑬ |

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Figure 5-28. Set Special Relay Assembly (Class 1, Mode II) Sets, Wiring Harness (Sheet 4 of 5)

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| K112B16 | 16 | 24.50 | BLK MKG | J15-H | SOLDER | TB101-15a | ⑬ |
| K112C16 | ↑ | 23.50 | ↑ ↑ | J15-M | ↑ | TB101-15b | ↑ |
| L26C16 |  | 27.25 |  | J2-K |  | A5-8 |  |
| L25C16 |  | 20.00 |  | J2-J |  | A5-19 |  |
| X21T16 |  | 25.25 |  | J10-X |  | A5-20 |  |
| X22T16 |  | 31.25 |  | J10-Y |  | A5-7 |  |
| X98N16 |  | 31.00 |  | J10-N |  | TB101-16b |  |
| X98H16 |  | 25.50 |  | J15-B |  | TB101-16a |  |
| X98J16 |  | 24.50 |  | J15-F | ↓ | TB101-16a |  |
| X98K16 |  | 23.75 |  | J15-K | SOLDER | TB101-16b |  |
| X96A16 |  | 32.75 |  | T101-2 | ⑱ | TB101-17b |  |
| X96B16 |  | 26.00 |  | J15-A | SOLDER | TB101-17a |  |
| X96C16 | ↓ | 25.50 |  | J15-E | SOLDER | TB101-17a |  |
| X96D16 | 16 | 25.00 | ↓ ↓ | J15-J | SOLDER | TB101-17b | ↓ |
| X195F16 | 16 | 31.25 | BLK MKG | T101-1 | ⑱ | TB102-13a | ⑬ |
| V65C12 | 12 | 28.25 | RED MKG | J5-X | SOLDER | TB101-18b | ⑲ |
|  |  |  |  |  |  |  |  |
| V64C12 | 12 | 29.00 | RED MKG | J5-Y | SOLDER | TB101-19b | ⑲ |
|  |  |  |  |  |  |  |  |
| P55AB16N | 16 | 15.00 | RED MKG | J50-W | SOLDER | GND STUD | ⑭ |
| P62A16 | ↑ | 27.50 | RED MKG | J50-H | ↑ | TB101-20a | ⑬ |
| P62E16 |  | 27.25 | RED MKG | J50-b |  | TB101-20b | ⑬ |
| X9YY16C | ↓ | 17.00 | BLK MKG | J15-S |  | TB102-2b | ⑬ |
| X12BB16N | 16 | 16.50 | BLK MKG | J15-P |  | TB102-3b | ⑬ |
| P55M12N | 12 | 19.25 | RED MKG | J10-0 | ↓ | GND STUD | ⑮ |
| P55CR16N | 16 | 19.50 | ↑ ↑ | J10-Z | SOLDER | GND STUD | ⑭ |
| P140D12 | 12 | 6.00 | ↓ ↓ | R13-1 | ⑮ | K3-1 | ⑰ |
| P142A12 | 12 | 26.50 | RED MKG | J5-Y | ⑮ | K3-2 | ⑰ |
| P200F16 | 16 | 32.00 | RED MKG | K11-4 | ⑬ | TB102-20a | ⑬ |
|  | ↑ |  |  |  |  |  |  |
| X9W16C |  | 30.00 | BLK MKG | K11-1 | ⑬ | TB102-2b | ⑬ |
| X9Y16C |  | 27.00 | ↑ ↑ | K12-1 | ⑬ | TB102-1b | ⑬ |
| K103A16 |  | 30.00 |  | J54-N | SOLDER | TB106-1 | ⑬ |
| K104A16 |  | 32.00 |  | J54-T | ↑ | TB106-3 | ⑬ |
| K105A16 |  | 10.00 |  | J54-E |  | R28-R | ⑱ |
| K106A16 |  | 11.00 | ↓ ↓ | J54-H | ↓ | R28-M | ⑱ |
| K107A16 |  | 12.00 | BLK MKG | J54-F | SOLDER | R28-L | ⑱ |
| P59A16 |  | 17.00 | RED MKG | K12-4 | ⑬ | K16-7 | ⑬ |
| P71A16 |  | 17.00 | RED MKG | K11-8 | ⑬ | K12-3 | ⑬ |
| K108A16 |  | 30.00 | BLK MKG | TB106-5 | ⑬ | J54-P | SOLDER |
| K109A16 |  | 31.00 | BLK MKG | TB106-6 | ⑬ | J54-R | ↑ |
| P148A16 |  | 28.00 | RED MKG | J10-I | SOLDER | J29-K |  |
| P149A16 |  | 28.00 | ↑ ↑ | J10-K | ↑ | J29-J |  |
| P150A16 |  | 28.00 | ↓ ↓ | J10-R | ↓ | J29-M | ↓ |
| P151A16 |  | 28.00 | RED MKG | J10-P | SOLDER | J-29-N | SOLDER |
| X12EE16N | ↓ | 32.00 | BLK MKG | K11-2 | ⑬ | TB102-4b | ⑬ |
| X12FF16N | 16 | 33.00 | BLK MKG | K12-2 | ⑬ | TB102-3b | ⑬ |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |

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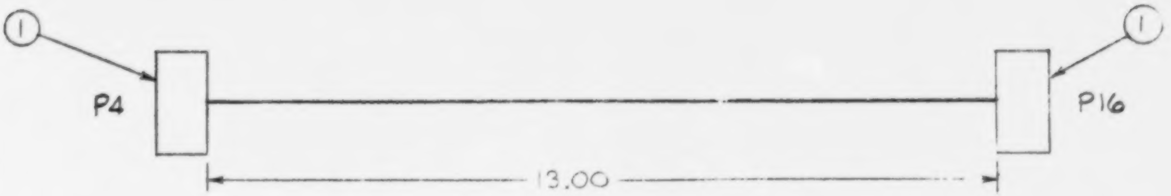
Figure 5-28. Set Special Relay Assembly (Class 1, Mode II) Sets, Wiring Harness (Sheet 5 of 5)



NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. WIRING SHALL BE NEATLY LACED THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ②, LOCATED AT INTERVALS NOT TO EXCEED THREE INCHES BETWEEN STRAPS.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. INSTALL NYLON FILLER PLUGS ③ IN UNUSED OPENING OF CONNECTOR BUSHING.

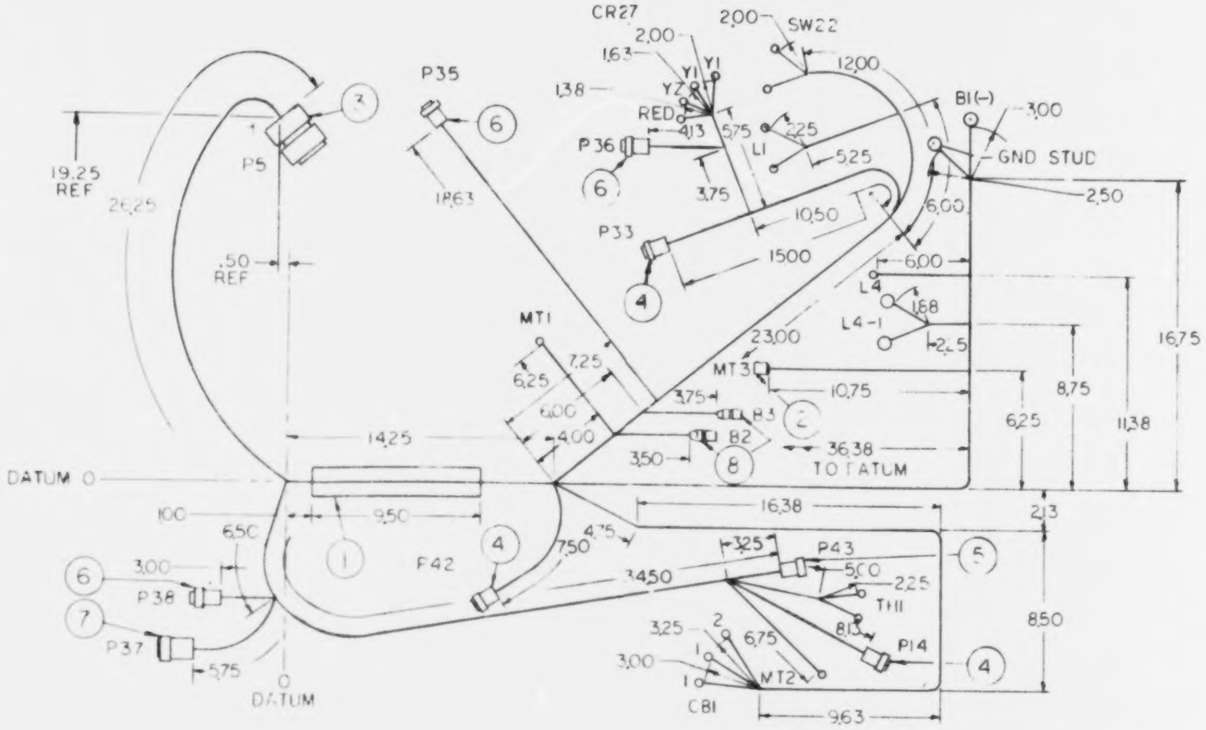
| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X7G16A | 16 | 14.50 | BLACK MKG | P4-A | SOLDER | P16-A | SOLDER |
| X8G16B | ↑ | ↑ | ↑ | ↑ -B | ↑ | ↑ -B | ↑ |
| X9N16C |  |  |  | -C |  | -C |  |
| X115D16 |  |  |  | -D |  | -D |  |
| X116D16 |  |  |  | -E |  | -E |  |
| X117D16 |  |  |  | -F |  | -F |  |
| D24G16 |  |  |  | -G |  | -G |  |
| X12Y16N |  |  |  | -K |  | -K |  |
| X12Z16N |  |  |  | -L |  | -L |  |
| X12AA16N |  |  |  | -M |  | -M |  |
| K101A16 | ↓ | ↓ | ↓ | ↓ -N | ↓ | ↓ -N | ↓ |
| K102A16 | 16 | 14.50 | BLACK MKG | P4-S | SOLDER | P16-S | SOLDER |
|  |  |  |  |  |  |  |  |

| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 4 | AR | WIRE AN-16, COLOR WHITE | MIL-W-5086/2 |
| 3 | 10 | PLUG, END SEAL, ELEC CONN |  |
| 2 | AR | STRAP, CABLE, ADJUSTABLE |  |
| 1 | 2 | CONNECTOR |  |

LIST OF MATERIAL

ME 6115-545-34/5-29

Figure 5-29. Load Measuring Unit Interconnecting, Wiring Harness


CR27
2.00
1.63
1.38
Y1
YZ
RED
2.00
SW22
12.00
B1(-)
3.00
GND STUD
2.50
P35
⑥
1.863
P36
4.13
5.75
2.25
L1
5.25
⑥
3.75
10.50
6.00
P33
15.00
④
6.00
L4
1.88
L4-1
2.25
23.00
16.75
MT1
MT3
10.75
8.75
11.38
6.25
7.25
6.00
3.75
B3
②
6.25
4.00
3.50
B2
⑧
36.38
TO DATUM
14.25
DATUM 0
19.25 REF
26.25
③
P5
.50 REF
1.00
6.50
9.50
①
P42
④
4.75
7.50
16.38
2.13
3.25
P43
⑤
5.00
2.25
TH1
34.50
8.13
P14
④
8.50
3.25
2
6.75
3.00
1
1
MT2
CB1
9.63
⑥
3.00
P38
⑦
P37
5.75
0
DATUM

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| P207C16 | 16GA | 65.50 | RED MKG | P5 - A | SOLDER | P14-B | SOLDER |
| P202C16 | | 38.50 | | - B | | P37-J | |
| P201C16 | | 48.50 | | - C | | P42-B | |
| P44H16 | | 38.50 | | - D | | P37-A | |
| P58E16 | | 48.50 | | - E | | P42-D | |
| P81D16 | | 38.50 | | - F | | P37-D | |
| P198D16 | | 73.00 | | - G | | P35-B | |
| P46D16 | | 35.50 | | - H | | P38-A | SOLDER |
| E39D16 | | 50.50 | | - I | | MT1 | ⑨ |
| E38D16 | | 63.50 | | - J | | MT2 | ⑨ |
| E37D16 | | 81.00 | | - K | | MT3 | ⑦ |
| P40NA16 | | 82.00 | | - M | | CB1-2 | ⑪ |
| P80N16 | | 84.50 | | - P | | SW22 | ⑪ |
| P80P16 | | 61.00 | | - R | | P43-A | SOLDER |
| P55K16N | | 83.50 | | - S | | L1 | ⑪ |
| P48C16 | | 38.50 | | - U | | P37-B | SOLDER |
| P54A16 | | 38.50 | | - V | | P37-C | |
| P200H16 | | 38.50 | | - W | | P37-F | |
| P52A16 | | 65.50 | | - Y | | P14-D | |
| P200G16 | | 65.50 | | - Z | | P14-C | |
| P68B16 | | 86.00 | | - b | | P33-D | |
| P50DD16 | | 86.00 | | - c | | P33-A | |
| P50EE16 | | 86.00 | | - e | | P33-C | SOLDER |
| P51F16 | | 52.00 | | - f | | B2 | ⑧ |
| P55UU16N | | 35.50 | | - g | SOLDER | P38-B | SOLDER |
| P55EF16N | | 89.00 | | - h | ⑪ | CR27-Y1 | SOLDER |
| P50HH16 | 16GA | 73.00 | RED MKG | P5- k | SOLDER | P35-A | SOLDER |

| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| P200N16 | 16GA | | RED MKG | P5 - m | SOLDER | P42-C | SOLDER |
| P47J16 | 16GA | | | - n | | P37-G | SOLDER |
| P80R16 | 16GA | | | - p | | P37-H | SOLDER |
| P142B12 | 12GA | | | - v | | L4(COIL) | ⑭ |
| P55N12N | 12GA | | | - t | | B1(-) | ⑫ |
| P51R16 | 16GA | | | - r | | B2 | ⑧ |
| P141C12 | 12GA | | | - z | | CB1-1 | ⑫ |
| P140A12 | | | | - w | | L4-1 | ⑮ |
| V65F12 | | | | - x | | TH1 | ⑬ |
| V64F12 | | | | P5- y | | TH1 | ⑬ |
| P141D12 | | | | P43-B | | CB1-1 | ⑬ |
| P555S12N | 12GA | | | P43-C | | GND STUD | [illegible] |
| P69A16 | 16GA | | | P33-B | | CR27-YZ | ⑪ |
| P140C16 | | | | P37-E | | L4-1 | ⑫ |
| P53A16 | | | | P14-A | SOLDER | P42-A | SOLDER |
| P86A16 | | | | SW22 | ⑪ | L1 | ⑪ |
| P77A16 | | | | CR27-RED | ⑪ | P36-A | SOLDER |
| P55EY16N | 16GA | | RED MKG | CR27-Y1 | ⑪ | P36-B | SOLDER |

NOTES:

1. INTERPRET DWG PER MIL-STD-100.
2. ALL WIRES ⑳㉑ SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ⑯⑰. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK OUT AND AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHS.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. INSTALL NYLON FILLER PLUGS⑱⑲ IN UNUSED OPENINGS OF CONNECTOR BUSHING, ITEM NOS 3 THRU 7.

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Figure 5-30. Engine Accessories, Wiring Harness (Sheet 1 of 3)

| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION OR NOTE |
|---|---|---|---|
| 1 | A/R | INSULATING SLEEVING, ELEC, FLEXIBLE, | |
| | | TREATED-PER MIL-I-3190B, CL B-A-1, | |
| | | COLOR BLACK, SIZE .768 I.D. | |
| 2 | 1 | CONN., ELECT., FEMALE | |
| 3 | 1 | CONNECTOR. PLUG, ELEC STR | |
| 4 | 3 | | |
| 5 | 1 | | |
| 6 | 3 | CONNECTOR, PLUG, ELEC STR | |
| 7 | 1 | CONNECTOR, PLUG, ELEC STR | |
| 8 | 2 | CONNECTOR, DISCONNECT | |
| 9 | 2 | TERMINAL, LUG, CRIMP STYLE | |
| | | | |
| 11 | 9 | TERMINAL, LUG, CRIMP STYLE | |
| 12 | 1 | | |
| 13 | 5 | | |
| 14 | 1 | TERMINAL, LUG, CRIMP STYLE | |

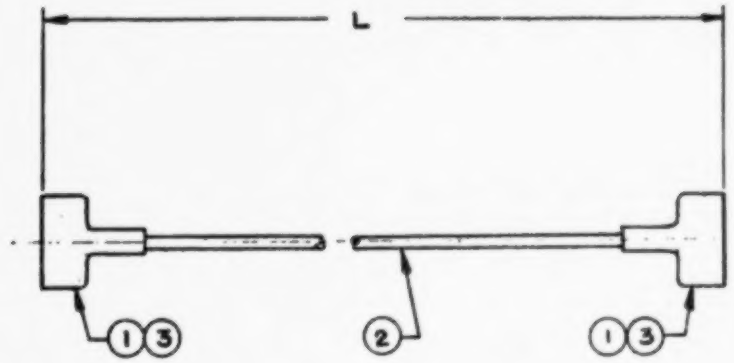
ME 6115-545-34/5-30(2)

Figure 5-30. Engine Accessories, Wiring Harness (Sheet 2 of 3)

| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION OR NOTE |
|---|---|---|---|
| 15 | 1 | TERMINAL, LUG, CRIMP STYLE | |
| 16 | A/R | STRAP, CABLE, ADJUSTABLE | |
| 17 | A/R | STRAP, CABLE, ADJUSTABLE | |
| 18 | 1 | PLUG, END SEAL, ELEC CONN | |
| 19 | 8 | PLUG, END SEAL, ELEC CONN | |
| 20 | A/R | WIRE, 12 GA. COLOR: WHITE | MIL-W-5086/2 |
| 21 | A/R | WIRE, 16 GA. COLOR: WHITE | " |
| 22 | A/R | SOLDER | QQ-S-571 |
| 23 | 1 | TERMINAL, LUG, CRIMP STYLE | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

ME 6115-545-34/5-30(3)

Figure 5-30. Engine Accessories, Wiring Harness (Sheet 3 of 3)

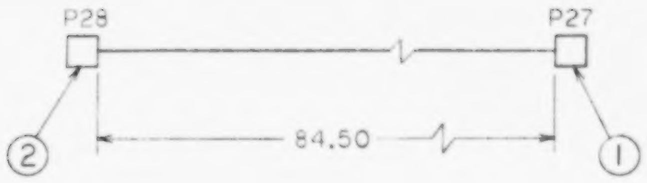


| DASH NO. | L - LENGTH |
|---|---|
| 69-772 -2 | 300 INCHES |
| 69-772 -1 | 360 INCHES |

NOTES:
1. ALL CONDUCTOR ENDS TO BE STRIPPED .250 INCH AND SOLDER TINNED BEFORE ASSEMBLY.
2. SOLDERING PROCESS TO BE PER MIL-S-6872
3. CONNECT LIKE PINS OF CONNECTORS TOGETHER
4. FOR INTERPRETATION OF:
   DIMENSIONING AND TOLERANCING,
   SEE MIL-STD-8

ME 6115-545-34/5-31

Figure 5-31. Paralleling Cable Assembly



| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| P55GK12N | 12 | 86.00 | RED MKG | P27-A | SOLDER | P28-A | SOLDER |
| P70B16 | 16 | ↑ | ↑ | P27-B | ↑ | P28-B | ↑ |
| V64G12 | 12 | │ | │ | P27-C | │ | P28-C | │ |
| P82B16 | 16 | ↓ | ↓ | P27-D | ↓ | P28-D | ↓ |
| P83B12 | 12 | 86.00 | RED MKG | P27-E | SOLDER | P28-E | SOLDER |

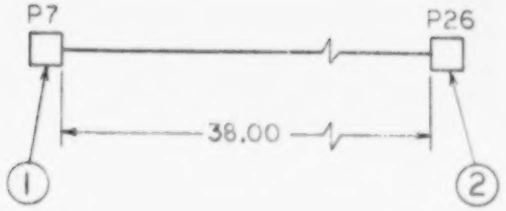
NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. WIRING SHALL BE NEATLY LACED THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ③, LOCATED AT INTERVALS NOT TO EXCEED THREE INCHES BETWEEN STRAPS.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRING NUMBERS SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.

| | | | |
|---|---|---|---|
| 5 | AR | WIRE, AN-12 COLOR WHITE | MIL W 5086/2 |
| 4 | AR | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| 3 | AR | STRAP, CABLE, ADJUSTABLE | |
| 2 | 1 | CONNECTOR, PLUG, ELEC, STR | |
| 1 | 1 | CONNECTOR, PLUG, ELEC, STR | |
| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIAL | | | |

ME 6115-545-34/5-32

Figure 5-32. Fuel Burning Winterization Kit, Wiring Harness



| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| P55E12N | 12 | 39.50 | RED MKG | P7-A | SOLDER | P26-A | SOLDER |
| P51C16 | 16 | ↑ | ↑ | P7-B | ↑ | P26-B | ↑ |
| V64A12 | 12 | │ | │ | P7-C | │ | P26-C | │ |
| V65A12 | 12 | ↓ | ↓ | P7-D | ↓ | P26-D | ↓ |
| P141G12 | 12 | 39.50 | RED MKG | P7-E | SOLDER | P26-E | SOLDER |

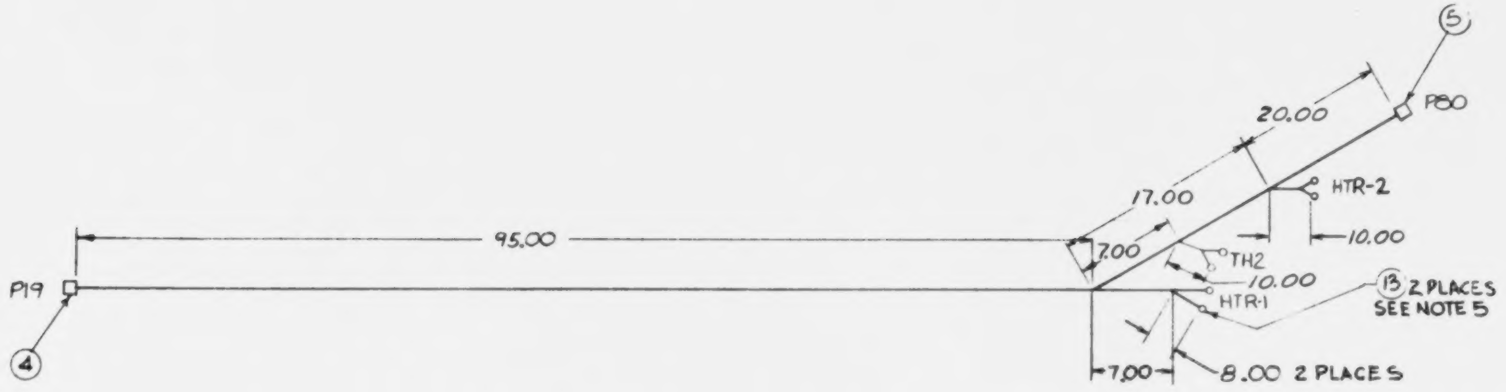
NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. WIRING SHALL BE NEATLY LACED THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ③, LOCATED AT INTERVALS NOT TO EXCEED THREE INCHES BETWEEN STRAPS.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.

| | | | |
|---|---|---|---|
| 5 | AR | WIRE, AN-12, COLOR WHITE | MIL-W-5086/2 |
| 4 | AR | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| 3 | AR | STRAP, CABLE, ADJUSTABLE | |
| 2 | 1 | CONNECTOR, PLUG, ELEC, STR | |
| 1 | 1 | CONNECTOR, PLUG, ELEC, STR | |
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIAL | | | |

ME 6115-545-34/5-33

Figure 5-33. Fuel Burning Winterization Control, Wiring Harness


⑤
P80
20.00
17.00
HTR-2
10.00
95.00
7.00
TH2
10.00
⑬ 2 PLACES
SEE NOTE 5
P19
HTR-1
④
7.00
8.00 2 PLACES

NOTES:
1. INTERPRET DRAWING PER MIL-STD-100.
2. WIRING SHALL BE NEATLY LACED THROUGH THE USE OF SELF-LOCKING NYLON STRAPS, LOCATED AT INTERVALS NOT TO EXCEED THREE INCHES BETWEEN STRAPS. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHES ⑧⑨.
3. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
4. INSTALL NYLON FILLER PLUG IN UNUSED OPENING OF CONNECTOR BUSHING ⑩⑪.
5. ITEM #13 SHOULD BE INSTALLED DURING UNIT ASSEMBLY. DO NOT USE HEAT TO SECURE.

ME 6115-545-34/5-34(1)

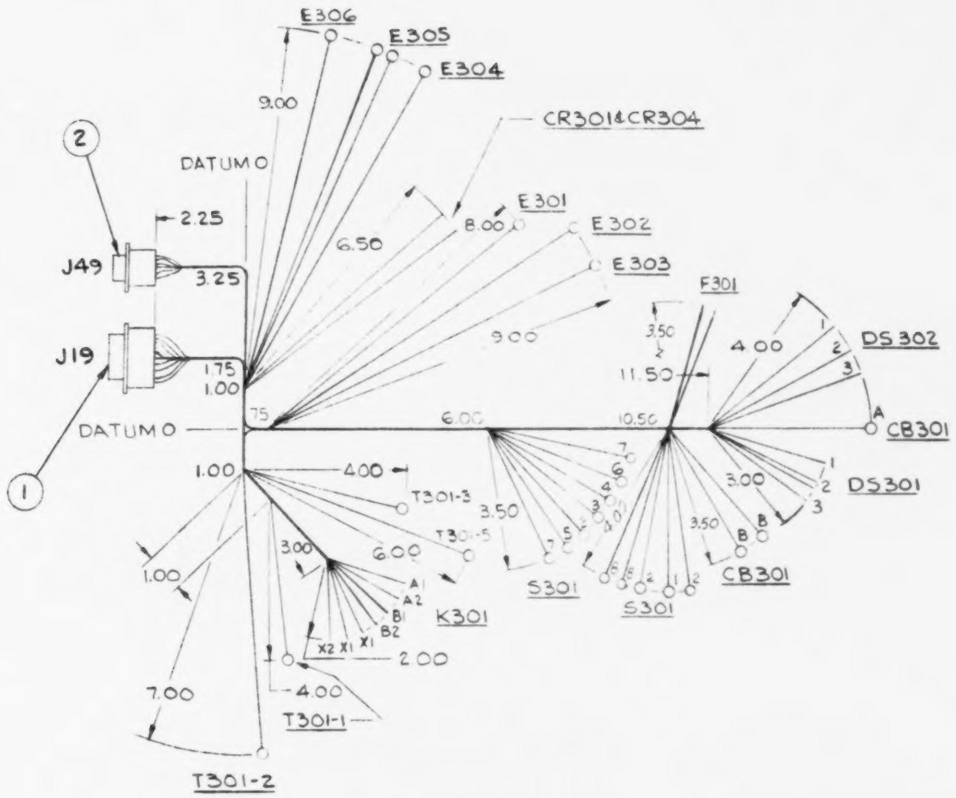
Figure 5-34. Electric Winterization Kit, Wiring Harness (Sheet 1 of 2)

| WIRE NO | SIZE REF | LENGTH REF. | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| V64E16 | 16 | 112.00 | RED MKG | TH 2 | ⑦ | P19-H | SOLDER |
| V65E16 | ↑ | 112.00 | RED MKG | TH 2 | ⑦ | P19-A | ↑ |
| P90B16 | │ | 132.50 | BLACK MKG | P19 -J | SOLDER | P80-A | ↓ |
| P91B16 | │ | 132.50 | ↑ | ↑ -K | ↑ | P80-B | SOLDER |
| X11EB16C | │ | 110.00 | │ | -L | │ | HTR-1-1 | ⑦ |
| X14EC16C | │ | 122.00 | │ | ↓ -M | │ | HTR-2-1 | ⑦ |
| X13EC16N | ↓ | 110.00 | ↓ | P19 -B | ↓ | HTR-1-2 | ⑦ |
| X15EB16N | 16 | 122.00 | BLACK MKG | P19 -C | SOLDER | HTR-2-2 | ⑦ |
| | | | | | | | |
| | | | | | | | |

| | | | |
|---|---|---|---|
| 13 | AR | INSULATION SLEEVING, 901D BLACK | MIL-I-23053/12 CLASS 1 |
| | | | |
| 11 | 5 | PLUG, END SEAL, ELEC CONN | |
| 10 | 2 | PLUG, END SEAL, ELEC CONN | |
| 9 | AR | STRAP, CABLE, ADJUSTABLE | |
| 8 | AR | STRAP, CABLE, ADJUSTABLE | |
| 7 | 6 | TERMINAL, LUG, CRIMP STYLE | |
| | | | |
| 5 | 1 | CONNECTOR, PLUG, ELEC STR | |
| 4 | 1 | CONNECTOR, PLUG, ELEC STR | |
| | | | |
| | | | |
| 1 | | WIRE, AN-16, COLOR WHITE | MIL-W-5086/2 |
| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIAL | | | |

ME 6115 545-34/5-34(2)

Figure 5-34. Electric Winterization Kit, Wiring Harness (Sheet 2 of 2)


E306
E305
E304
9.00
CR301&CR304
2
DATUM 0
E301
E302
2.25
6.50
8.00
E303
J49
3.25
F301
3.50
4.00
DS302
1
2
3
9.00
J19
1.75
1.00
11.50
DATUM 0
.75
6.00
10.50
A
CB301
1.00
4.00
7
6
1
DS301
2
T301-3
3.00
3
4
3.50
3
T301-5
4.00
1
3.00
6.00
7
5
3.50
B
B
1.00
A1
A2
S301
S301
CB301
B1
K301
B2
X2
X1
X1
2.00
4.00
7.00
T301-1
T301-2

NOTES:

1. INTERPRET DWG PER MIL-STD-100.
2. ⑥⑦ALL WIRE SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING NYLON STRAPS.⑧⑨. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND AT PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.
3. ⑫SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.
5. ⑩⑪CUT INSULATION TUBING IN HALF-INCH PIECES AND INSTALL AROUND WIRES AND PINS AT RECEPTACLES.

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Figure 5-35. Electric Heater Control Box, Wiring Harness (Sheet 1 of 2)

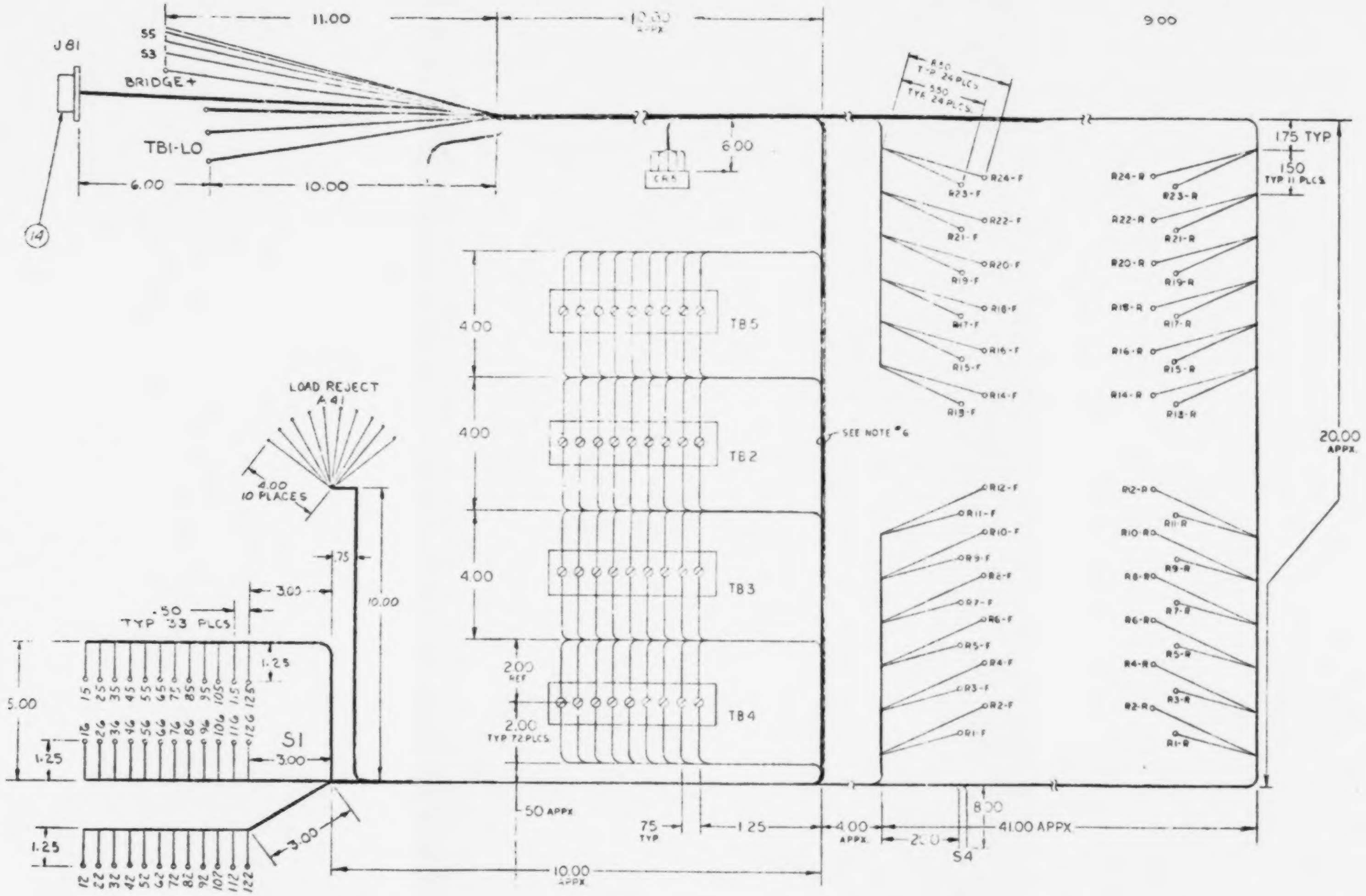
| WIRE NO. | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X9EA12C | 12 | 21.00 | BLK MKG | J49-A | SOLDER | CB301-A | ⑤ |
| X10EA16C | 16 | 20.50 | BLK MKG | CB301-B | ④ | K301-A2 | SOLDER |
| X10EB16C | 16 | 7.50 | BLK MKG | CB301-B | ④ | S301-1 | ③ |
| | | | | | | | |
| X11EA16C | 16 | 10.00 | BLK MKG | J19-L | SOLDER | K301-A1 | SOLDER |
| X12EA12N | 12 | 14.50 | ↑ ↑ | J49-B | ↑ | S301-8 | ⑬ |
| X13EB16N | 16 | 13.50 | | J19-B | ↑ | S301-7 | ③ |
| X14EB16C | 16 | 18.50 | | J19-M | SOLDER | S301-2 | ③ |
| X14EA16C | ↑ | 8.50 | | S301-2 | ③ | F301 | SOLDER |
| X301A16 | | 12.50 | | T301-3 | ④ | CR301 | SOLDER |
| X302A16 | | 14.50 | | T301-5 | ④ | CR304 | SOLDER |
| P90A16 | | 13.50 | | J19-J | SOLDER | E301 | ③ |
| P90C16 | | 24.50 | | E302 | ③ | DS302-1 | SOLDER |
| P90D16 | | 18.50 | | E303 | ③ | S301-5 | ③ |
| P91A16 | | 12.50 | | J19-K | SOLDER | E304 | ↑ |
| P91C16 | | 13.00 | | DS302-2 | SOLDER | S301-3 | ↑ |
| P91D16 | | 25.50 | | DS301-3 | SOLDER | E306 | ③ |
| P91E16 | | 25.50 | | E305 | ③ | DS302-3 | SOLDER |
| P91F16 | | 19.50 | | E305 | ③ | S301-3 | ③ |
| P99B16 | | 20.50 | ↑ ↑ | K301-X2 | SOLDER | DS301-2 | SOLDER |
| P99A16 | | 12.00 | BLK MKG | S301-4 | ③ | DS301-2 | SOLDER |
| V64F16 | | 13.50 | RED MKG | J19-H | SOLDER | S301-6 | ③ |
| V65F16 | ↑ | 10.00 | RED MKG | J19-A | SOLDER | K301-X1 | SOLDER |
| V65G16 | 16 | 20.50 | RED MKG | K301-X1 | SOLDER | DS301-1 | SOLDER |
| X13EA16N | 16 | 17.50 | BLK MKG | T301-2 | ④ | S301-7 | ③ |
| X12EB16N | 16 | 21.50 | ↑ ↑ | K301-B2 | SOLDER | S301-8 | ③ |
| X15EA16N | 16 | 11.00 | ↑ ↑ | K301-B1 | SOLDER | J19-C | SOLDER |
| X16EA16C | 16 | 20.50 | BLK MKG | F301 | SOLDER | T301-1 | ④ |

| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 13 | 1 | TERMINAL, LUG, CRIMP STYLE | |
| 12 | | | |
| 11 | AR | INSUL, SLEEVING, .187 I.D., BLK | MIL-I-23053/5, CLASS 1 |
| 10 | AR | INSUL, SLEEVING, .125 I.D., BLK | MIL-I-23053/5, CLASS 1 |
| 9 | AR | STRAP, CABLE, ADJUSTABLE | |
| 8 | AR | STRAP, CABLE, ADJUSTABLE | |
| 7 | AR | WIRE, AN 12, COLOR WHITE | MIL-W-5086/2 |
| 6 | AR | WIRE, AN 16, COLOR WHITE | MIL-W-5086/2 |
| 5 | 1 | TERMINAL, LUG, CRIMP STYLE | |
| 4 | 6 | TERMINAL, LUG, CRIMP STYLE | |
| 3 | 18 | TERMINAL, LUG, CRIMP STYLE | |
| 2 | 1 | CONNECTOR, RECEPTACLE, ELEC | |
| 1 | 1 | CONNECTOR, RECEPTACLE, ELEC | |

LIST OF MATERIAL

ME 6115-545-34/5-35(2)

Figure 5-35. Electric Heater Control Box, Wiring Harness (Sheet 2 of 2)


J81
55
53
BRIDGE+
TB1-LO
11.00
10.00 APPX
6.00
10.00
6.00
(14)
CR5
9.00
.880 TYP 24 PLCS
.550 TYP 24 PLCS
1.75 TYP
1.50 TYP 11 PLCS
20.00 APPX
R24-F
R23-F
R22-F
R21-F
R20-F
R19-F
R18-F
R17-F
R16-F
R15-F
R14-F
R13-F
R24-R
R23-R
R22-R
R21-R
R20-R
R19-R
R18-R
R17-R
R16-R
R15-R
R14-R
R13-R
SEE NOTE #6
R12-F
R11-F
R10-F
R9-F
R8-F
R7-F
R6-F
R5-F
R4-F
R3-F
R2-F
R1-F
R12-R
R11-R
R10-R
R9-R
R8-R
R7-R
R6-R
R5-R
R4-R
R3-R
R2-R
R1-R
4.00
4.00
4.00
TB5
TB2
TB3
TB4
2.00 REF
2.00 TYP 72 PLCS
LOAD REJECT
A41
4.00
10 PLACES
.75
3.00
10.00
.50
TYP 33 PLCS
1.25
5.00
1.25
15 25 35 45 55 65 75 85 95 105 115 125
16 26 36 46 56 66 76 86 96 106 116 126
S1
3.00
1.25
12 22 32 42 52 62 72 82 92 107 112 122
3.00
.50 APPX
.75 TYP
1.25
4.00 APPX
2.00
8.00
S4
41.00 APPX
10.00 APPX

NOTES:

1. Interpret Dwg. Per MIL-STD-100
2. All Wire Shall Be Neatly Laced Into Harnesses Through The Use Of Self Locking Nylon Straps (12). Lacing Straps Shall Be Located At Each Wire Break-Out And At Periodic Intervals Not To Exceed Three Inches.
3. Soldering Shall Be In Accordance With Requirement 5 of MIL-STD-454.
4. Wire Numbers Shall Be Stamped On 1-50 Inch Lengths Of MIL-I-23053 Sleeving (10)(11) And Placed Within 3 Inches Of Each End Of The Wire.
5. This Section Of Harness To Be Installed At Final Assembly.
6. Wiring Numbers Shall Be In Accordance With MIL-W-5082 Except That Length Between Adjacent Groups Of Numbers Shall Not Exceed Six Inches.

| | | |
|---|---|---|
| 16 | AR | WIRE, 16AW,COLOR, WHITE |
| 15 | 36 | TERM LUG, CRIMP STYLE |
| 14 | 1 | RECEPTICAL (J81) |
| 13 | AR | SOLDER |
| 12 | AR | STRAP, CABLE, ADJUSTABLE |
| 11 | AR | INSUL. SLEEVING 12 ID WHITE |
| 10 | AR | INSUL SLEEVING 19 ID WHITE |
| 9 | 36 | TERMINAL, LUG, CRIMP STYLE |
| 8 | 54 | TERMINAL, LUG, CRIMP STYLE |
| 7 | 11 | TERMINAL, LUG CRIMP STYLE |
| 6 | 8 | TERMINAL, LUG, CRIMP STYLE |
| 5 | 3 | TERMINAL, LUG, CRIMP STYLE |
| 4 | 36 | TERMINAL, LUG, CRIMP STYLE |
| 3 | AR | TEFLON WIRE #16GA, COLOR WHITE |
| 2 | AR | TEFLON WIRE, #10GA, COLOR WHITE |
| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION |

LIST OF MATERIAL

ME 6115-545-34/5-36(1)

Figure 5-36. Load Bank, Wiring Harness (Sheet 1 of 3)

| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP | WIRE TYPE |
|---|---|---|---|---|---|---|---|---|
| X0111B16A | 16 | 24.00 | BLACK MKG | S1-15 | ⑤ | TB3-9 | ④ | ③ |
| X0115A16A |  | 32.00 |  | S1-16 |  | TB5-9 |  |  |
| X0116A16A |  | 22.50 |  | S1-12 |  | TB4-1 |  |  |
| X0112B16A |  | 24.00 |  | S1-25 |  | TB3-8 |  |  |
| X0117A16A |  | 33.00 |  | S1-26 |  | TB5-8 |  |  |
| X0118A16A |  | 25.00 |  | S1-22 |  | TB4-2 |  |  |
| X0113B16A |  | 23.00 |  | S1-35 |  | TB3-7 |  |  |
| X0119A16A |  | 33.00 |  | S1-36 |  | TB5-7 |  |  |
| X0120A16A |  | 25.00 |  | S1-32 |  | TB4-3 |  |  |
| X0114B16A |  | 23.00 |  | S1-45 |  | TB3-6 |  |  |
| X0121A16A |  | 33.00 |  | S1-46 |  | TB5-6 |  |  |
| X0122A16A |  | 24.00 |  | S1-42 |  | TB4-4 |  |  |
| X0211B16B |  | 24.50 |  | S1-55 |  | TB3-5 |  |  |
| X0215A16B |  | 33.00 |  | S1-56 |  | TB5-5 |  |  |
| X0216A16B |  | 22.00 |  | S1-52 |  | TB4-5 |  |  |
| X0212B16B |  | 23.50 |  | S1-65 |  | TB3-4 |  |  |
| X0217A16B |  | 33.00 |  | S1-66 |  | TB5-4 |  |  |
| X0218A16B |  | 21.00 |  | S1-62 |  | TB4-6 |  |  |
| X0213B16B |  | 25.00 |  | S1-75 |  | TB2-9 |  |  |
| X0219A16B |  | 32.00 |  | S1-76 |  | TB5-3 |  |  |
| X0220A16B |  | 34.00 |  | S1-72 |  | TB4-7 |  |  |
| X0214B16B |  | 24.00 |  | S1-65 |  | TB2-8 |  |  |
| X0221A16B |  | 24.00 |  | S1-86 |  | TB5-2 |  |  |
| X0222A16B |  | 24.00 |  | S1-82 |  | TB4-8 |  |  |
| X0311B16C |  | 24.50 |  | S1-95 |  | TB2-7 |  |  |
| X0315A16C |  | 32.00 |  | S1-96 |  | TB5-1 |  |  |
| X0316A16C |  | 17.00 |  | S1-92 |  | TB4-9 |  |  |
| X0312B16C |  | 24.50 |  | S1-105 |  | TB2-6 |  |  |
| X0317A16C |  | 30.00 |  | S1-106 |  | TB2-1 |  |  |
| X0318A16C |  | 28.00 |  | S1-102 |  | TB3-1 |  |  |
| X0313B16C |  | 25.00 |  | S1-115 |  | TB2-5 |  |  |
| X0319A16C |  | 31.00 |  | S1-116 |  | TB2-2 |  |  |
| X0320A16C |  | 26.00 |  | S1-112 |  | TB3-2 |  |  |
| X0314B16C |  | 24.50 |  | S1-125 |  | TB2-4 |  |  |
| X0321A16C |  | 27.00 |  | S1-126 |  | TB2-3 |  |  |
| X0322A16C | 16 | 24.00 |  | S1-122 | ⑤ | TB3-3 | ④ | ③ |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| X0410E10N | 10 | 79.50 |  | TB1-LO | ⑤ | R7-R | ⑥ | ② |
| X0410F10N | 10 | 66.50 |  | TB1-LO | ⑤ | R15-R | ⑥ |  |
| X0410G10N | 10 | 61.00 |  | TB1-LO | ⑤ | R23-R | ⑥ |  |
| X0410H10N | 10 | 9.00 |  | R1-R | ⑧ | R3-R | ⑧ |  |
| X0410J10N |  | 9.00 |  | R3-R |  | R5-R |  |  |
| X0410K10N |  | 9.00 |  | R5-R |  | R7-R |  |  |
| X0410L10N |  | 9.00 |  | R9-R |  | R11-R |  |  |
| X0410M10N |  | 9.00 |  | R11-R |  | R13-R |  |  |
| X0410N10N |  | 9.00 |  | R13-R |  | R15-R |  |  |
| X0410P10N |  | 9.00 |  | R17-R |  | R15-R |  |  |
| X0410R10N |  | 9.00 |  | R19-R |  | R21-R |  |  |
| X0410S10N | 10 | 9.00 | BLACK MKG | R21-R | ⑧ | R23-R | ⑧ | ② |
|  |  |  |  |  |  |  |  |  |

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Figure 5-36. Load Bank, Wiring Harness (Sheet 2 of 3)

| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP | WIRE TYPE |
|---|---|---|---|---|---|---|---|---|
| P552A16N | 16 | 53.00 | BLACK MKG | J81-D | SOLDER | A41-4 | ⑦ | ③ |
| P502A16 | | | | J81-C | | A41-3 | | |
| K1022A16 | | | | J81-B | | A41-2 | | |
| K1012A16 | | | | J81-A | | A41-1 | | |
| P502B16 | | | | J81-G | | A41-3 | | |
| K1022B16 | | | | J81-F | | A41-2 | | |
| K1012B16 | | | | J81-E | | A41-1 | | |
| P552B16N | | 53.00 | | J81-H | SOLDER | A41-4 | ⑦ | |
| P01A16 | | 68.00 | | CR5+ | ⑦ | S4-2 | SOLDER | |
| P01B16 | | 24.00 | | A41-5 | ⑦ | CR5+ | ⑥ | |
| P02A16 | | 29.00 | | CR5- | ⑥ | S3-4 | SOLDER | |
| P03A16 | | 49.00 | | A41-6 | ⑦ | S5-1 | ⑥ | |
| P04A16 | | 68.00 | | S5-2 | ⑥ | S4-1 | SOLDER | |
| P04B16 | 16 | 23.00 | | S5-2 | ⑥ | S3-3 | SOLDER | ③ |
| X0111C10A | 10 | 22.00 | | TB3-9 | 15 | R2-F | ⑧ | ② |
| X0115D10A | | 32.00 | | TB5-9 | | R1-F | | |
| X0116B10A | | 63.00 | | TB4-1 | | R2-R | | |
| X0112C10A | | 25.00 | | TB3-8 | | R4-F | | |
| X0117B10A | | 42.00 | | TB5-8 | | R3-F | | |
| X0118B10A | | 66.00 | | TB4- | | R4-R | | |
| X0113C10A | | 27.00 | | TB3-7 | | R6-F | | |
| X0119B10A | | 36.00 | | TB5-7 | | R5-F | | |
| X0120B10A | | 64.00 | | TB4-3 | | R6-R | | |
| X0114C10A | | 29.00 | | TB3-6 | | R8-F | | |
| X0121B10A | | 46.00 | | TB5-6 | | R7-F | | |
| X0122B10A | | 65.00 | | TB4-4 | | R8-R | | |
| X0211C10B | | 31.00 | | TB3-5 | | R10-F | | |
| X0215D10B | | 40.00 | | TB5-5 | | R9-F | | |
| X0216B10B | | 86.00 | | TB4-5 | | R10-R | | |
| X0212C10B | | 34.00 | | TB3-4 | | R12-F | | |
| X0217B10B | | 39.50 | | TB5-4 | | R11-F | | |
| X0218B10B | | 66.00 | | TB4-6 | | R12-R | | |
| X0213C10B | | 29.00 | | TB2-9 | | R14-F | | |
| X0219B10B | | 29.00 | | TB5-3 | | R13-F | | |
| X0220B10B | | 84.50 | | TB4-7 | | R14-R | | |
| X0214C10B | | 30.00 | | TB2-8 | | R16-F | | |
| X0221B10B | | 26.50 | | TB5-2 | | R15-F | | |
| X0222B10B | | 79.50 | | TB4-8 | | R16-R | | |
| X0311C10C | | 28.00 | | TB2-7 | | R18-F | | |
| X0315B10C | | 26.00 | | TB5-1 | | R17-F | | |
| X0316B10C | | 77.50 | | TB4-9 | | R18-R | | |
| X0312C10C | | 31.00 | | TB2-6 | | R20-F | | |
| X0317B10C | | 28.00 | | TB2-1 | | R19-F | | |
| X0318B10C | | 76.50 | | TB3-1 | | R20-R | | |
| X0313C10C | | 28.00 | | TB2-5 | | R22-F | | |
| X0319B10C | | 26.50 | | TB2-2 | | R21-F | | |
| X0320B10C | | 75.00 | | TB3-2 | | R22-R | | |
| X0314C10C | | 25.75 | | TB2-4 | | R24-F | | |
| X0321B10C | | 25.00 | | TB2-3 | | R23-F | | |
| X0322B10C | 10 | 73.50 | BLACK MKG | TB3-3 | 15 | R24-R | ⑧ | ② |
| | | | | | | | | |

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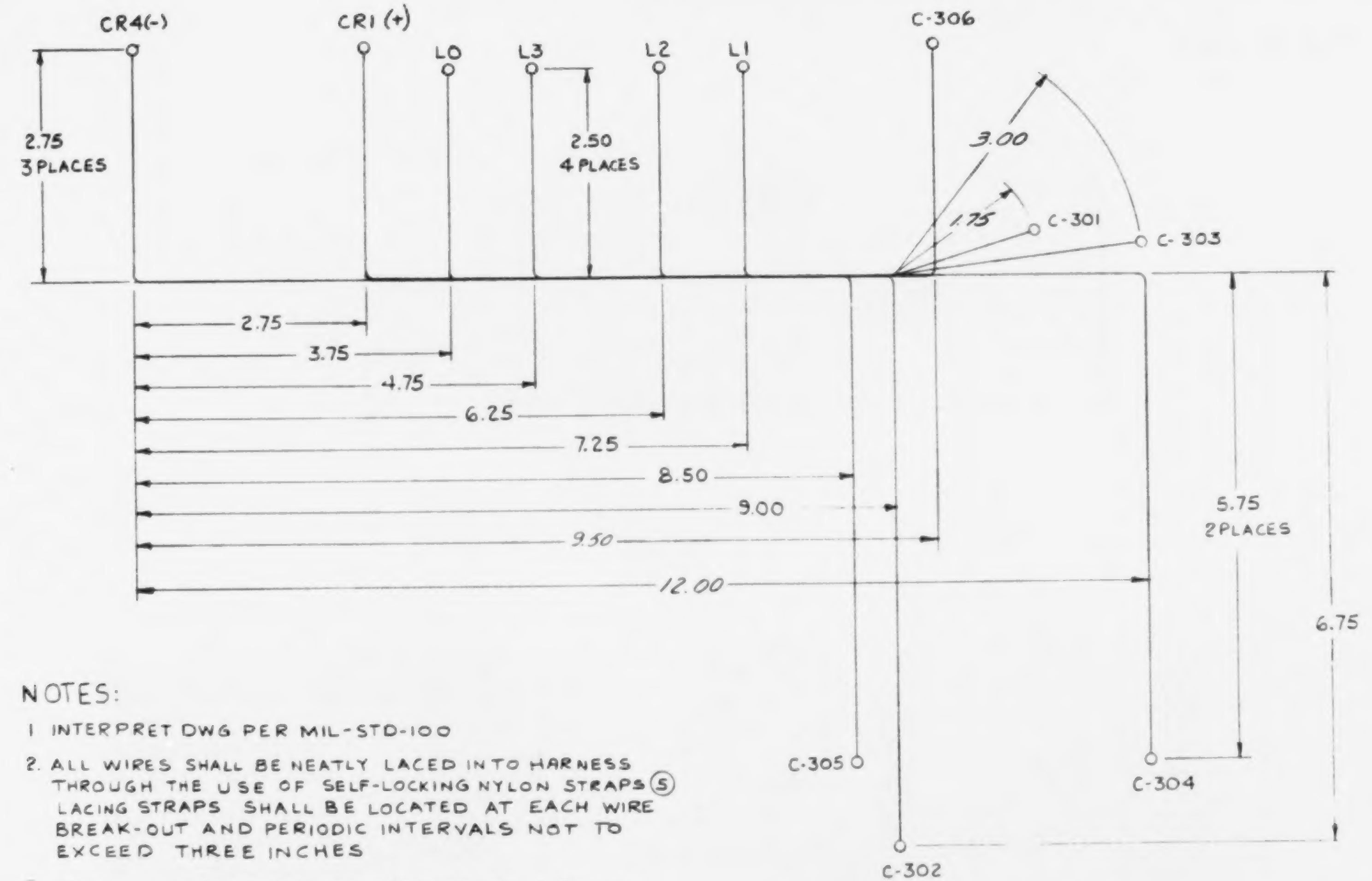
Figure 5-36. Load Bank, Wiring Harness (Sheet 3 of 3)


CR4(-)
CR1 (+)
L0
L3
L2
L1
C-306
2.75
3 PLACES
2.50
4 PLACES
3.00
1.75
C-301
C-303
2.75
3.75
4.75
6.25
7.25
8.50
9.00
9.50
12.00
5.75
2 PLACES
6.75
C-305
C-304
C-302

NOTES:

1 INTERPRET DWG PER MIL-STD-100

2. ALL WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ⑤ LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES

3 WIRE NUMBERS SHALL BE STAMPED ON 1.50 INCH LENGTHS OF SLEEVING ② AND PLACED WITHIN THREE INCHES OF EACH END OF EACH WIRE.

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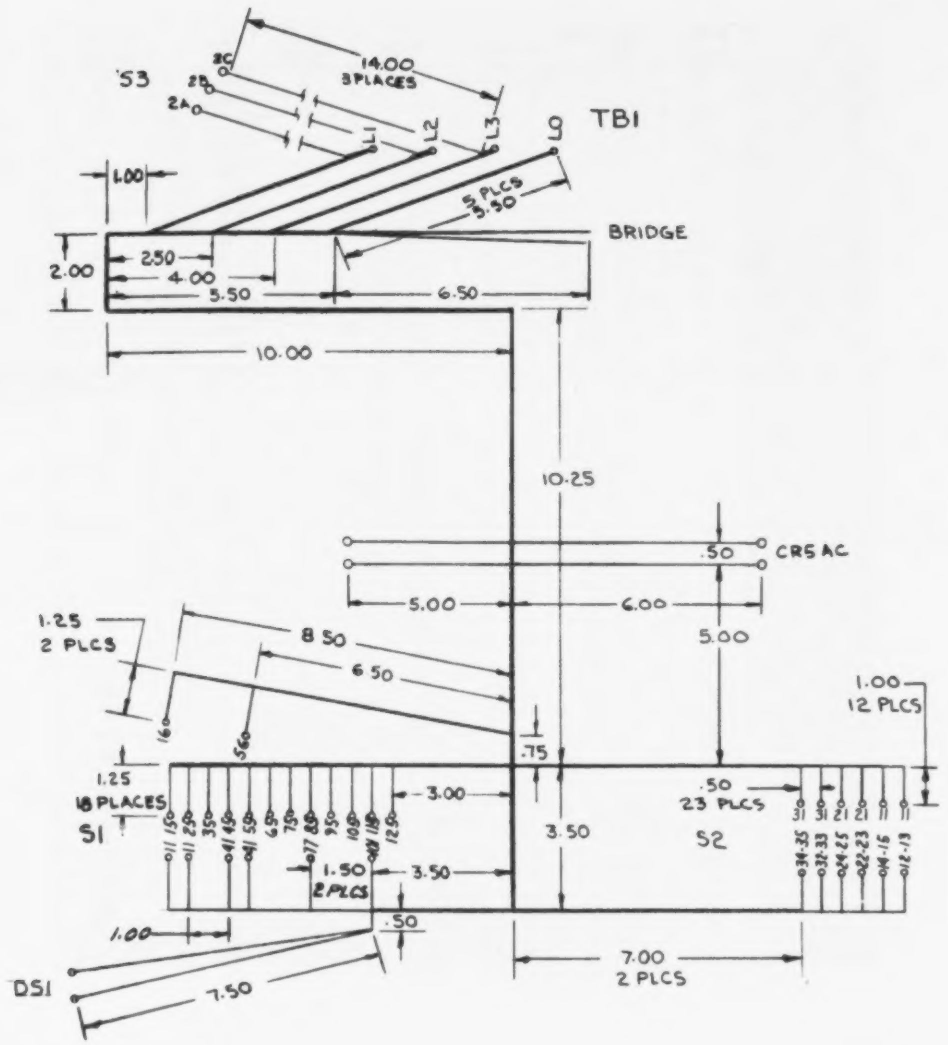
Figure 5-37. Load Bank Capacitor (Sheet 1 of 2)

| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X0110E16A | 16 | 13.00 |  | TB1-L1 | ④ | C-304 | ③ |
| X0210E16B | 16 | 8.25 |  | TB1-L2 | ④ | C-303 | ③ |
| X0310E16C | 16 | 13.50 |  | TB1-L3 | ④ | C-302 | ③ |
| X0410W16N | 16 | 9.50 |  | TB1-L0 | ④ | C-301 | ③ |
| P05A16 | 16 | 12.25 |  | CR1(+) | ③ | C-306 | ③ |
| P06A16 | 16 | 17.00 |  | CR4(-) | ③ | C-305 | ③ |

|  |  |  |  |
|---|---|---|---|
| 5 | AR | STRAP, CABLE, ADJUSTABLE |  |
| 4 | 4 | TERMINAL LUG, CRIMP STYLE |  |
| 3 | 8 | TERMINAL LUG, CRIMP STYLE |  |
| 2 | AR | INSUL SLEEVING .06 I.D. BLACK | MIL-I-23053/5 CLASS I |
| 1 | AR | WIRE, TEFLON 16GA. COLOR WHT | MIL-W-16878/4 |
| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIAL |  |  |  |

ME 6115-545-34/5-37

Figure 5-37. Load Bank Capacitor (Sheet 2 of 2)



S3
3C
2B
2A
14.00
3 PLACES
L1
L2
L3
L0
TB1
1.00
5 PLCS
3.50
BRIDGE
2.00
2.50
4.00
5.50
6.50
10.00
10.25
CR5 AC
.50
5.00
6.00
5.00
1.25
2 PLCS
8.50
6.50
1.00
12 PLCS
16
56
.75
1.25
18 PLACES
S1
11 15
11 25
35
41 45
41 55
65
75
77 85
95
105
111 115
125
3.00
1.50
2 PLCS
3.50
3.50
.50
23 PLCS
S2
31
31
21
21
11
11
34-35
32-33
24-25
22-23
14-15
12-13
1.00
.50
7.00
2 PLCS
DS1
7.50

NOTES:

1. INTERPRET DWG PER MIL-STD-100.
2. ALL WIRE SHALL BE NEATLY LACED INTO HARNESSES THROUGH THE USE OF SELF-LOCKING NYLON STRAPS④. LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND AT INTERVALS NOT TO EXCEED THREE INCHES.
3. SOLDERING SHALL BE IN ACCORDANCE WITH REQUIREMENT 5 OF MIL-STD-454.
4. WIRE NUMBERING SHALL BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT LENGTH BETWEEN ADJACENT GROUPS OF NUMBERS SHALL NOT EXCEED SIX INCHES.

ME 6115-545-34/5-38(1)

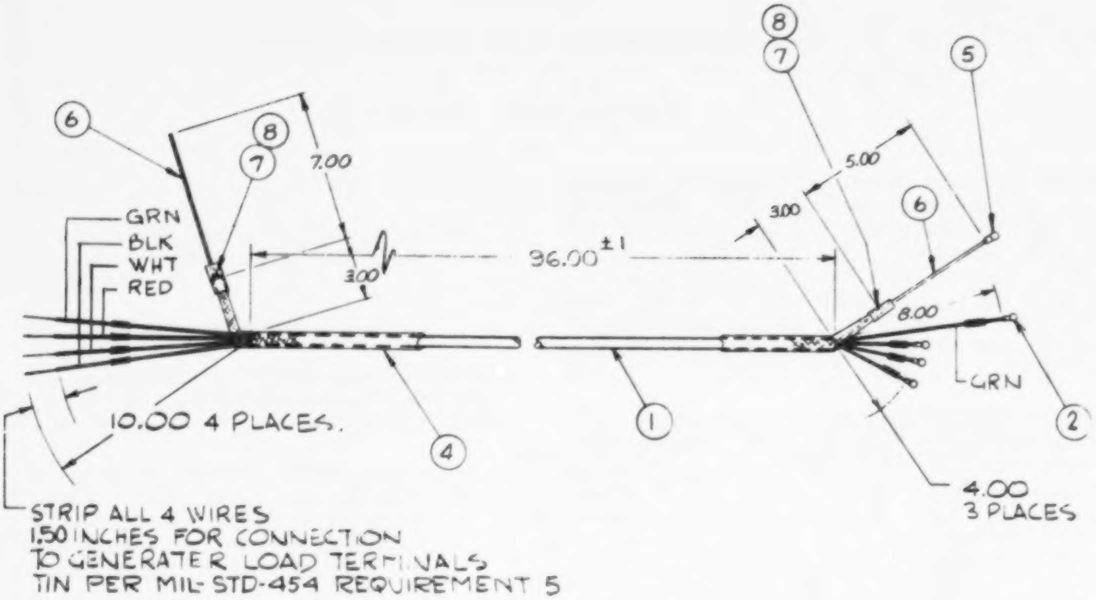
Figure 5-38. Load Bank Control Panel, Wiring Harness (Sheet 1 of 2)

| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X0410A10N | 10 | 44.75 | BLK MKG | S1-11 | ⑤ | TB1-L0 | ⑥ |
| X0410B10N | 10 | 44.75 | ↑ | S1-41 | ↑ | TB1-L0 | ↑ |
| X0410C10N | 10 | 44.75 | | S1-71 | | TB1-L0 | |
| X0410D10N | 10 | 44.75 | | S1-101 | | TB1-L0 | |
| X0110A12A | 12 | 32.75 | | S2-11 | | TB1-L1 | |
| X0110B12A | ↑ | 32.75 | | S2-11 | | TB1-L1 | |
| X0110C12A | | 32.75 | | S2-11 | | TB1-L1 | |
| X0110D12A | | 32.75 | | S2-11 | | TB1-L1 | |
| X0210A12B | | 34.25 | | S2-21 | | TB1-L2 | |
| X0210B12B | | 34.25 | | S2-21 | | TB1-L2 | |
| X0210C12B | | 34.25 | | S2-21 | | TB1-L2 | |
| X0210D12B | | 34.25 | | S2-21 | | TB1-L2 | |
| X0310A12C | | 35.75 | | S2-31 | | TB1-L3 | |
| X0310B12C | | 35.75 | | S2-31 | | TB1-L3 | |
| X0310C12C | | 35.75 | | S2-31 | | TB1-L3 | ↓ |
| X0310D12C | | 35.75 | | S2-31 | | TB1-L3 | ⑥ |
| X0111A12A | | 7.75 | | S2-12 | | S1-15 | ⑤ |
| X0112A12A | | 8.25 | | S2-13 | | S1-25 | ↑ |
| X0113A12A | | 9.25 | | S2-14 | | S1-35 | |
| X0114A12A | | 9.75 | | S2-15 | | S1-45 | |
| X0211A12B | | 10.75 | | S2-22 | | S1-55 | |
| X0212A12B | | 11.25 | | S2-23 | | S1-65 | |
| X0213A12B | | 12.25 | | S2-24 | | S1-75 | |
| X0214A12B | | 12.75 | | S2-25 | | S1-85 | |
| X0311A12C | | 13.75 | | S2-32 | | S1-95 | |
| X0312A12C | | 14.25 | | S2-33 | | S1-105 | |
| X0313A12C | ↓ | 15.25 | | S2-34 | ↓ | S1-115 | ↓ |
| X0314A12C | 12 | 15.75 | | S2-35 | ⑤ | S1-125 | ⑤ |
| X0115B16A | 16 | 29.75 | | R25-1 | SOLDER | S1-16 | ⑦ |
| X0410T16N | 16 | 44.75 | | BRIDGE | SOLDER | S1-11 | ⑦ |
| X0215C16B | 16 | 23.50 | | DS1 | ⑦ | S1-56 | ⑦ |
| X0410U16N | 16 | 13.00 | | DS1 | ⑦ | S1-41 | ⑦ |
| X0215B16 | 16 | 15.00 | | CR5(AC) | ⑦ | S1-56 | ⑦ |
| X0410V16N | 16 | 20.00 | | CR5(AC) | ⑦ | TB1-L0 | ⑧ |
| X0110F4A | 4 | 15.00 | | TB1-L1 | ⑥ | S3-2A | ⑩ |
| X0210F4B | 4 | 15.00 | | TB1-L2 | ⑥ | S3-2B | ⑩ |
| X0310F4C | 4 | 15.00 | | TB1-L3 | ⑥ | S3-3C | ⑩ |
| X0115C16A | 16 | 12.00 | ↓ | R25-1 | SOLDER | R25-2 | SOLDER |
| X0515C16A | 16 | 13.75 | BLK MKG | R25-3 | SOLDER | BRIDGE | SOLDER |

| | | | |
|---|---|---|---|
| 10 | 3 | TERMINAL LUG, CRIMP STYLE | |
| 9 | AR | SOLDER | QQ-S-571 |
| 8 | 1 | TERMINAL, LUG, CRIMP STYLE | |
| 7 | 9 | TERMINAL, LUG, CRIMP STYLE | |
| 6 | 19 | TERMINAL, LUG, CRIMP STYLE | |
| 5 | 40 | TERMINAL, LUG, CRIMP STYLE | |
| 4 | AR | STRAP, CABLE, ADJUSTABLE | |
| 3 | AR | WIRE AN 10 WHITE | MIL-W-5086/2 |
| 2 | AR | WIRE AN 12 WHITE | MIL-W-5086/2 |
| 1 | AR | WIRE AN 16 WHITE | MIL-W-5086/2 |
| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIAL | | | |

ME 6115-545-34/5-38(2)

Figure 5-38. Load Bank Control Panel, Wiring Harness (Sheet 2 of 2)


⑥
⑧
⑦
7.00
3.00
36.00 ±1
GRN
BLK
WHT
RED
10.00 4 PLACES.
④
①
⑧
⑦
⑤
5.00
3.00
⑥
8.00
GRN
②
4.00
3 PLACES
STRIP ALL 4 WIRES
1.50 INCHES FOR CONNECTION
TO GENERATER LOAD TERMINALS
TIN PER MIL-STD-454 REQUIREMENT 5

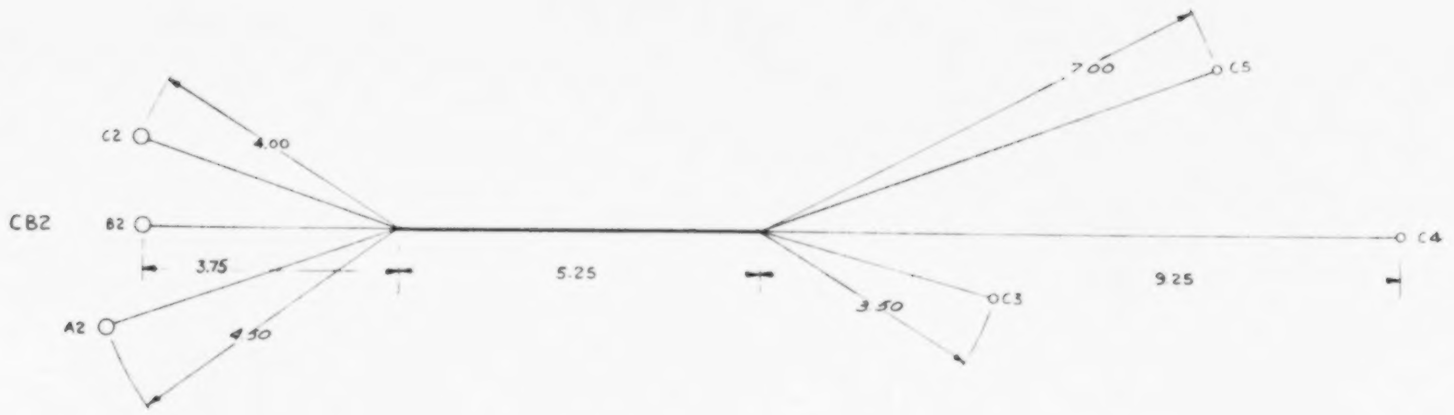
| WIRE INSULATION COLOR | WIRE NO | REF DES. |
|---|---|---|
| BLACK | X0204A | L1 |
| WHITE | X0204B | L2 |
| RED | X0204C | L3 |
| GREEN | X0104N | L0 |

| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 8 | 4 IN. | INSUL SLEEVING .75 I.D. BLK | MIL-I-22053/5 CLASS I |
| 7 | AR | SOLDER | QQ-S-571 |
| 6 | 1 FT | SHIELDING, TINNED COPPER .203 I.D. | QQ-B-575 |
| 5 | 1 | TERMINAL, LUG | MS 25036-157 |
| 4 | 11 FT. | SHIELDING, TINNED COPPER, 1.50 I.D. | QQ-B-575 |
| 3 | AR | INSUL SLEEVING .51 I.D. BLK | MIL-I-23053/5, CLASS I |
| 2 | 4 | TERMINAL | MS 25036-123 |
| 1 | 9.5 FT | CABLE #4 | CO-04 HLF4/4 1340 |

LIST OF MATERIAL

ME 6115-545-34/5-39

Figure 5-39. Special Purpose Cables Assembly - 70-1274 for Generator Set to Load Bank Main Power Cable



| WIRE NO | SIZE REF | LENGTH REF | COLOR | FROM | END PREP | TO | END PREP |
|---|---|---|---|---|---|---|---|
| X14H16 | 16 | 13.25 |  | C3 | ③ | CB2-A2 | ② |
| X15L16 | 16 | 18.25 |  | C4 | ③ | CB2-B2 | ② |
| X16F16 | 16 | 16.25 |  | C5 | ③ | CB2-C2 | ② |

NOTES:

1 INTERPRET DWG PER MIL-STD-100

2 ALL WIRES SHALL BE NEATLY LACED INTO HARNESS THROUGH THE USE OF SELF-LOCKING NYLON STRAPS ④ LACING STRAPS SHALL BE LOCATED AT EACH WIRE BREAK-OUT AND PERIODIC INTERVALS NOT TO EXCEED THREE INCHES.

| | | | |
|---|---|---|---|
| 4 | AR | STRAP, CABLE ADJUSTABLE | |
| 3 | 3 | TERMINAL LUG. CRIMP STYLE | |
| 2 | 3 | TERMINAL LUG CRIMP STYLE | |
| 1 | AR | WIRE 16AN COLOR WHITE | MIL-W-5086/2 |
| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION | SPECIFICATION |
| LIST OF MATERIAL | | | |

ME 6115-545-34/5-40

Figure 5-40. RFI Capacitors, Wiring Harness

# CHAPTER 6

# LOAD CONNECTION GROUP REPAIR INSTRUCTIONS

## Section I. INTRODUCTION

### 6-1. Scope.

This chapter contains repair instructions for the main load contactor and current transformer of the load connection group.

### 6-2. Load Connection Group Description.

a. The load connection group consists of the main load contactor, load terminal board assembly, current transformer assembly, and reconnection board.

b. The main load contactor connects the main generator output to the load. The contactor closes when the load contactor switch (S-3) (refer to Operator and Organizational Maintenance Manual) is placed in the on position momentarily.

c. The load terminal board provides a means of connection to the generator set load. The contactor connects the generator output to the load through the load terminal board.

d. The output cables of the generator pass through the cores of the current transformers. When the generator is connected to a load, a proportional current is induced in the current transformer secondary. This secondary current is used by the excitation system as a current boost during a short circuit and cross current compensation during parallel operation. The current transformer secondary is also used to operate the ammeter and wattmeter circuits in the control panel and it is used in the load measuring unit circuit.

e. The reconnection board permits reconnection of the generator phase windings to give optional output voltages. Both ends of each coil of each phase winding run from the generator to a stud on the reconnection board. A changeover board, with copper bus bars, is mounted so that the studs contact the bus bars. The bus bars are so designed that by moving the changeover board to one of two positions, the generator phase coils may be connected in series or parallel for 120/208 volt or 240/416 volt operation.

f. Refer to the Operator and Organizational Maintenance Manual for maintenance instruction procedures covering the load terminal board and reconnection board.

## Section II. MAIN LOAD CONTACTOR

### 6-3. Removal and Disassembly.

a. Removal. Refer to Operator and Organizational Maintenance Manual and remove the main load contactor.

b. Disassembly. See figure 6-1 or figure 6-1D (used on Serial Numbers FZ-01639 on, for 50/60 Hz and Serial Numbers FZ-06463 on, for 400 Hz) and disassemble the main load contactor as illustrated.

### 6-4. Cleaning, Inspection, and Testing.

a. Cleaning. Clean all components with cloth dampened in cleaning solvent, Federal Specification P-D-680.

b. Inspection. Refer to Operator and Organizational Maintenance Manual.

c. Testing. Refer to Operator and Organizational Maintenance Manual.

### 6-5. Repair.

a. Replace contactor actuator coil if defective.

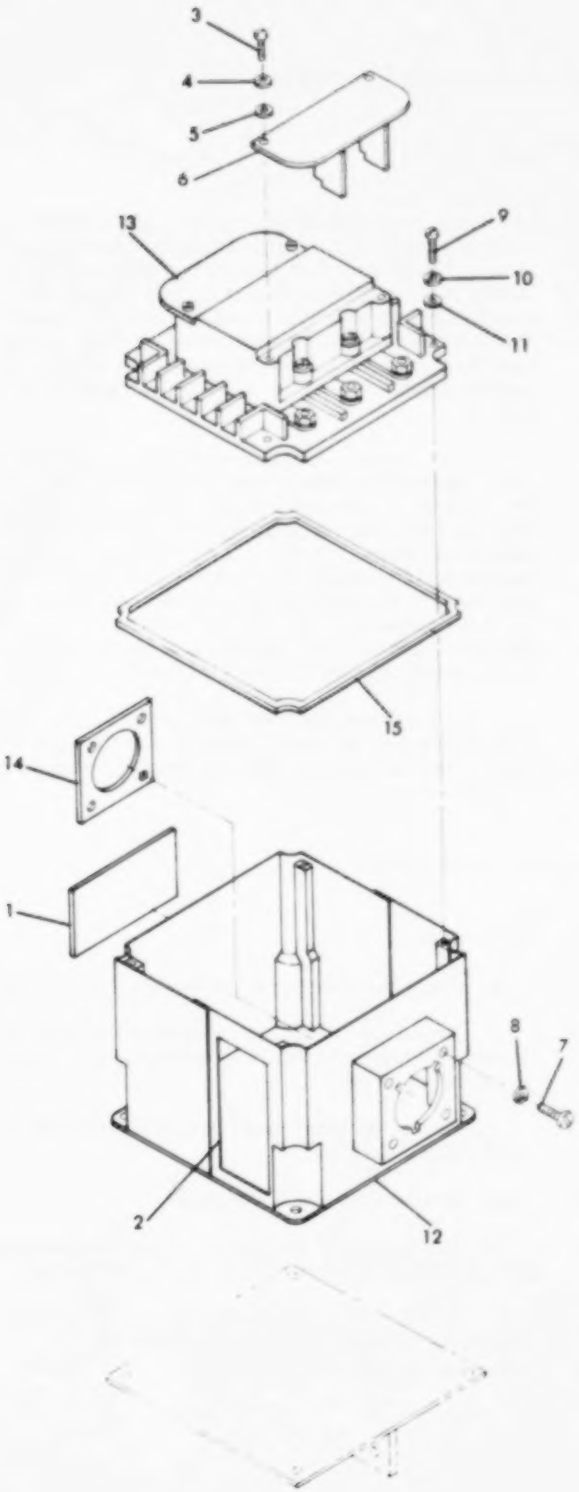
b. Replace contacts in contactor if badly pitted or burned. When one contact is damaged, all contacts must be replaced.

c. Repair damaged threads with a die or by filing with a fine mill file.

### 6-6. Reassembly and Installation.

a. Reassembly. See figure 6-1 and reassemble the main load contactor observing the following:

(1) After assembly of the operator assembly (23) refer to figure 6-1A and perform the following adjustment procedures: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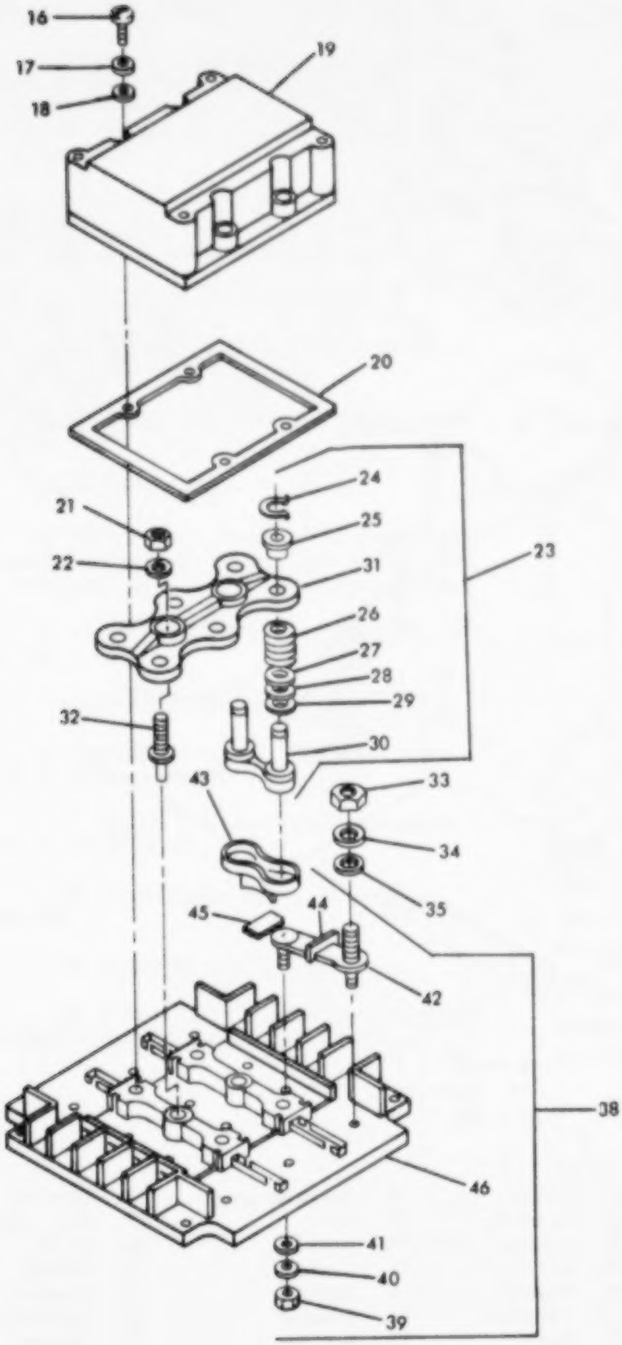
13
9
10
11
15
14
1
8
7
2
12

1. Plate
2. Plate
3. Screw
4. Washer
5. Washer
6. Cover
7. Screw
8. Washer
9. Screw
10. Washer
11. Washer
12. Cover assy
13. Contactor assy
14. Gasket
15. Gasket

ME 6115-545-34/6-1(1) C1

Figure 6-1. Main Load Contactor
(Sheet 1 of 3)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32
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43
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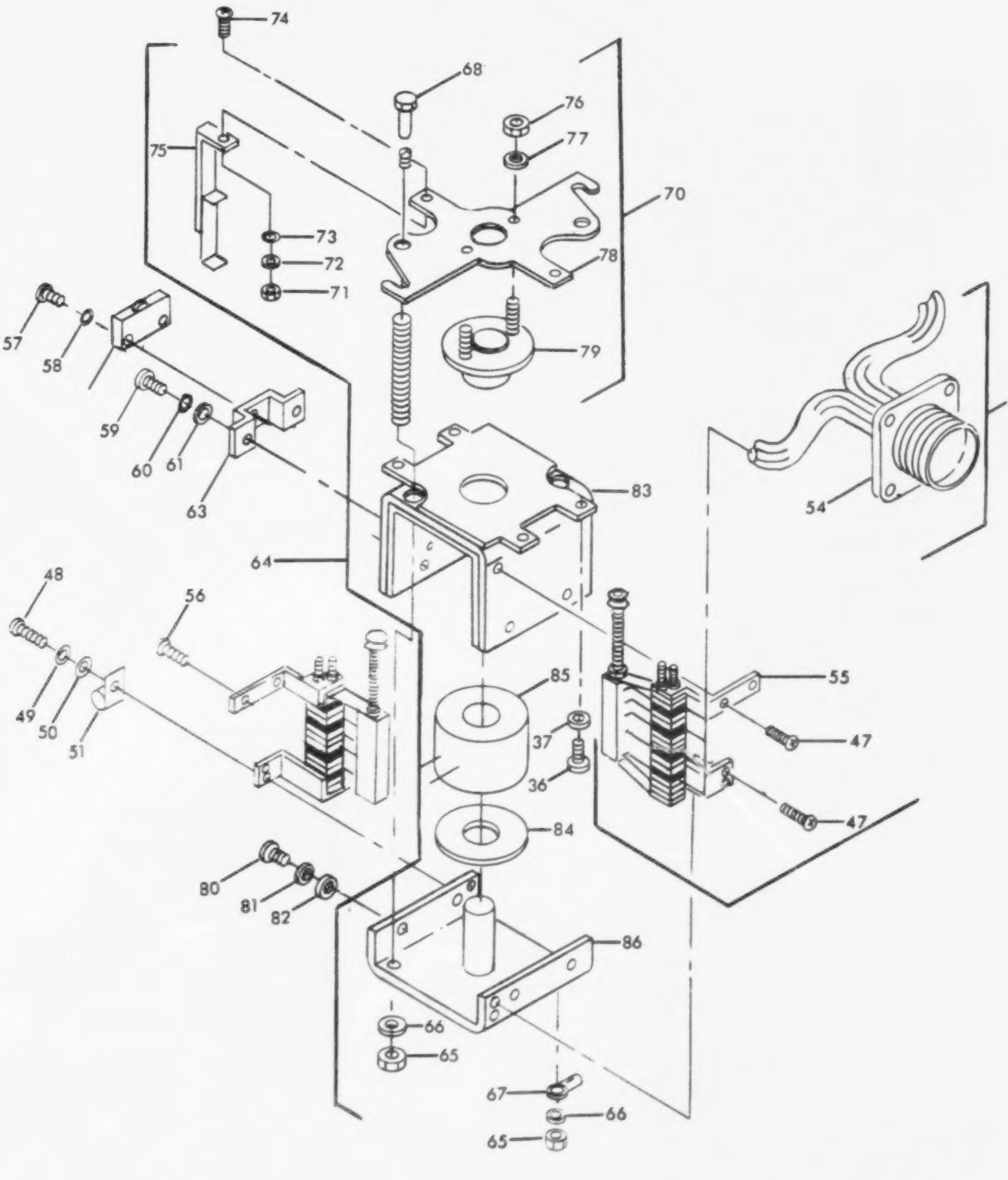
34
35
45
44
42
38
46
41
40
39

16. Screw
17. Washer
18. Washer
19. Chamber
20. Gasket
21. Nut
22. Washer
23. Operator assy.
24. Ring, retaining
25. Bushing, locating
26. Spring
27. Shim
28. Shim
29. Shim
30. Bridge assy.
31. Operator
32. Bushing, adjusting
33. Nut
34. Washer
35. Washer
36. Screw
37. Washer
38. Base assy.
39. Nut
40. Washer
41. Washer
42. Contact assy.
43. Arc chute
44. Grommet
45. Spacer
46. Base

ME 6115-545-34/6-1(2) C1

Figure 6-1. Main Load Contactor
(Sheet 2 of 3)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83
64
48
56
55
85
49
50
37
47
51
36
47
84
80
81
82
86
66
65
67
66
65

47. Screw
48. Screw
49. Washer
50. Washer
51. Clamp
52. Connector aux. contact assy.
53. Connector and wire assy.
54. Connector
55. Aux. contact assy
56. Aux. contact assy
57. Screw
58. Washer
59. Switch
60. Screw
61. Washer
62. Washer
63. Bracket
64. Actuator assy
65. Nut
66. Washer
67. Terminal
68. Rod
69. Spring
70. Operator assy
71. Nut
72. Washer
73. Washer
74. Screw
75. Bracket
76. Nut
77. Washer
78. Operator aux.
79. Core and rod
80. Screw
81. Washer
82. Washer
83. End Plate
84. Washer
85. Coil
86. Core and frame

ME 6115-545-34/6-1(3) C1

Figure 6-1. Main Load Contactor
(Sheet 3 of 3)

(a) Check each individual contact at its edge (insert A) with a force gauge. Preload should be between 1-1/2 - 2 1/2 lbs. This can be attained by adding or removing shim (see chart, figure 6-1A).

(b) Preload is checked by the initial breakaway of the E ring at point B, figure 6-1A. Preload should be between 1-1/2 to 2-1/2 lbs. This can be obtained by adding or removing shim (See chart, figure 6-1A).

(2) After assembly of the actuator assembly (64, figure 6-1), refer to figure 6-1B and perform the following adjustment procedures:

(a) Leave four screws (1) loose.

(b) Clamp assembly at points A and B to assure no air gap at points C and D.

(c) With assembly clamped, tighten four screws (1).

(d) Remove clamp.

(e) Insert feeler gauge (0.150 ± 0.010 in.) into movable core gap and adjust guide screws (2) evenly until gauge is snug throughout the parimeter.

(f) Secure after adjustment by tightening two nuts (3).

(3) Contactor adjustment.

(a) Contact overtravel. Refer to figure 6-1C and proceed as follows:

(1) Attach indicator lamp on ohmeter to terminal A1-A2 & C1-C2.

(2) Insert 0.035 gauge into movable core cap (A).

(3) Apply 24 VDC to coil.

(4) Adjust carrier bushings at point (B) until continuity is made on A1-A2 & C1-C2.

(5) Secure by tightening nuts (1).

(6) Recheck continuity at 0.035. No continuity at 0.040 readjust if necessary.

(b) Economizing switch. Refer to figure 6-1C and proceed as follows:

(1) Adjust switch bracket (3) to transfer switch. Check that white button is fully depressed and allow approximately 0.010 clearance between white button and tap operator (point C). Secure screws on bracket.

(2) Insert 0.010 gauge into movable core gap (A).

(3) Apply 24 VDC to coil.

(4) Adjust lower tap (D) by bending to transfer switch.

(5) Recheck

0.010 gauge transfer
0.018 gauge no transfer
Readjust if necessary

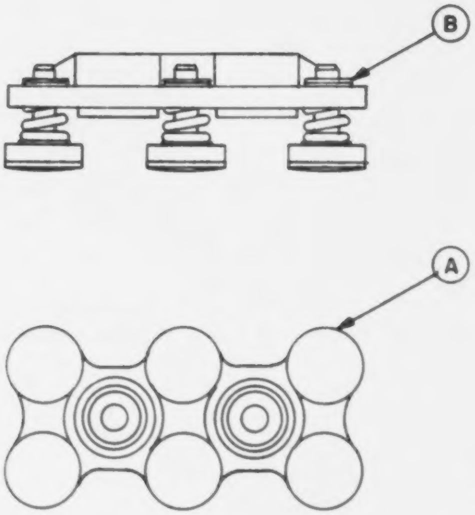
(c) Auxiliary contacts. Refer to figure 6-1C and proceed as follows:

(1) Before adjustment, set lift comb item (5) so that the deflector on the guide leaf springs (6) are near equal in energized and de-energized position. Secure by tightening nuts (4).

(2) Normally closed. Insert 0.018 guage between guide rod head and operator plate, (point D 2 places). Adjust stationary contacts to just touch the movable contact (use indicator light) - recheck with 0.025 gauge at point (D). No continuity. Readjust if necessary.

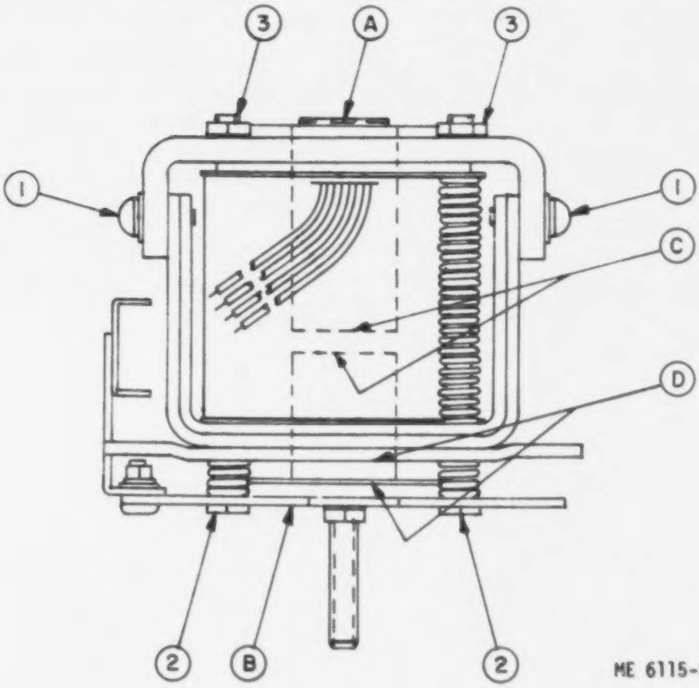
(3) Normally Open. Same as normally closed except shims are inserted into movable core gap (point A).

| CHART | LBS CHANGE |
|---|---|
| 10127-1 = .007 | .9 LBS |
| 10127-2 = .016 | 2 LBS |
| 10127-3 = .003 | .4 LBS |



ME 6115-545-34/6-1A C1

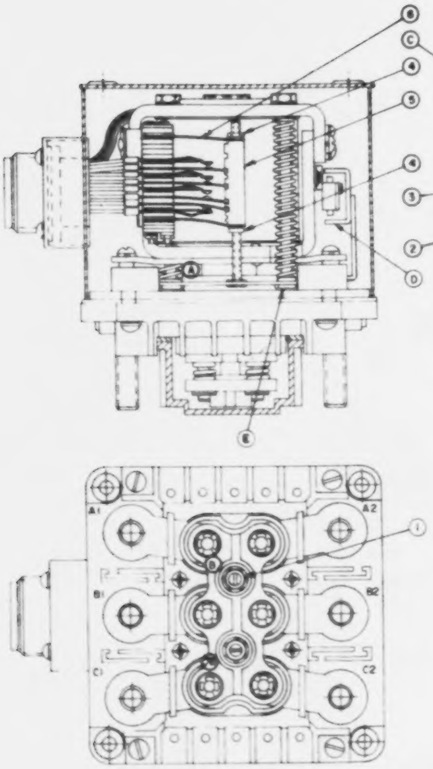
Figure 6-1A. Operator Assembly - Main Contact Adjustment Procedure



1. Screw
2. Screw
3. Nut

ME 6115-545-34/6-1B C1

Figure 6-1B. Actuator Assembly Adjustment Procedure


6
C
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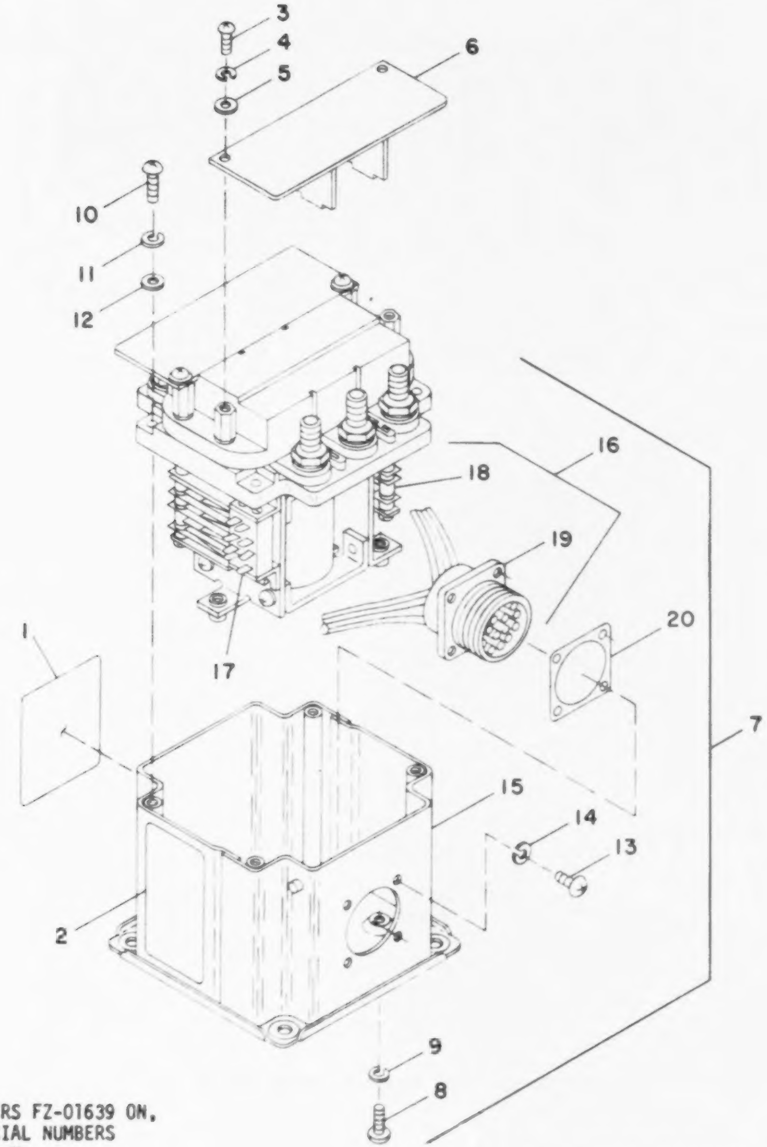
5
4
3
2
D
A
E
1
B
A1
A2
B1
B2
C1
C2

ME 6115-545-34/6-1C C3

1. Nut
2. Switch
3. Bracket
4. Nut
5. Aux. contact assy
6. Leaf spring

Figure 6-1C. Contactor Adjustment

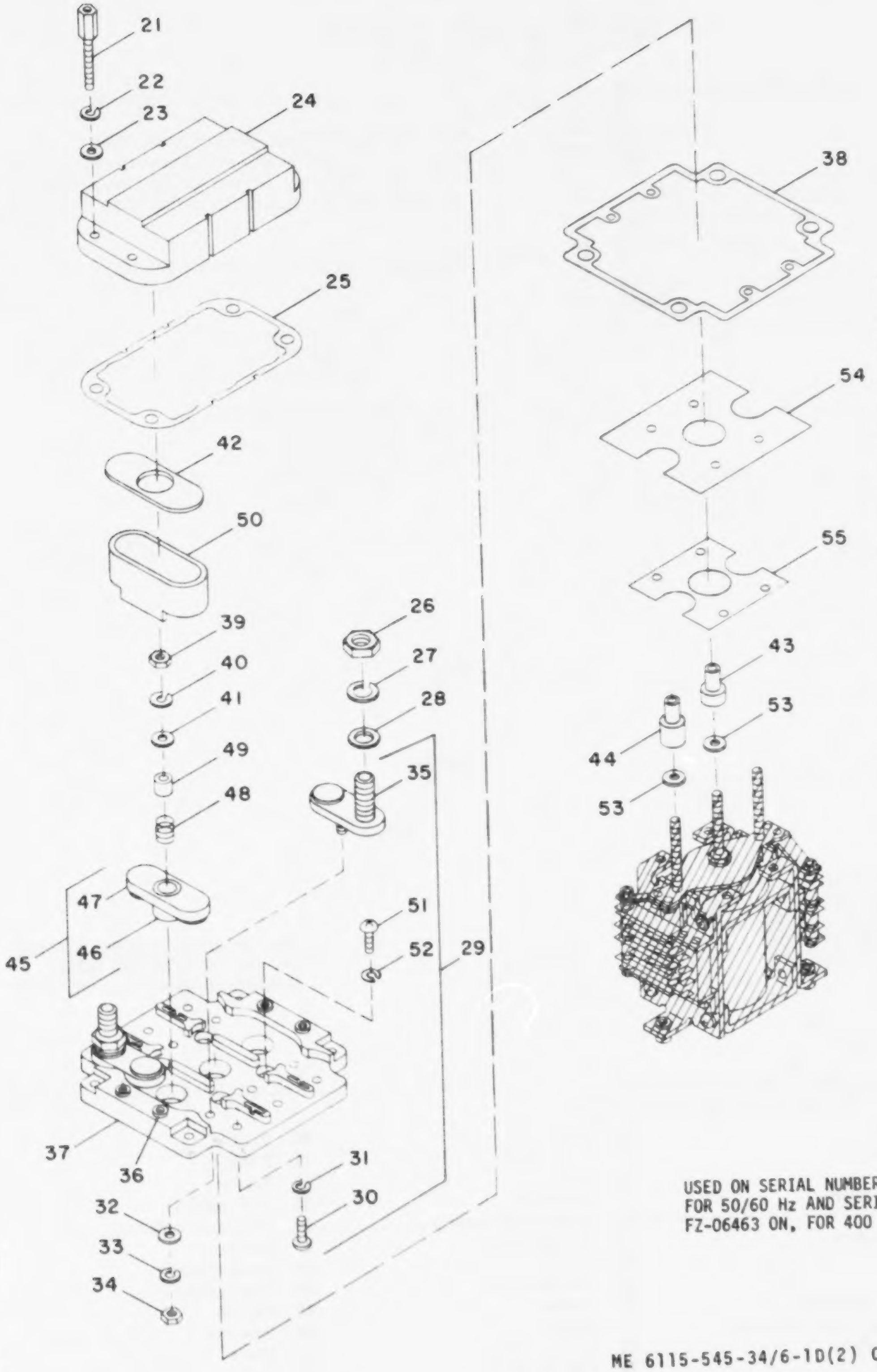


USED ON SERIAL NUMBERS FZ-01639 ON, FOR 50/60 Hz AND SERIAL NUMBERS FZ-06463 ON, FOR 400 Hz

ME 6115-545-34/6-1D(1) C3

1. Identification plate
2. Wiring diagram plate
3. Screw
4. Lock washer
5. Flat washer
6. Shield
7. Contactor subassy
8. Screw
9. Lock washer
10. Screw
11. Lock washer
12. Flat washer
13. Screw
14. Lock washer
15. Cover
16. Switch-Connector assy
17. Aux switch
18. Aux switch
19. Connector
20. Gasket

Figure 6-1D. Main Load Contactor (Sheet 1 of 3)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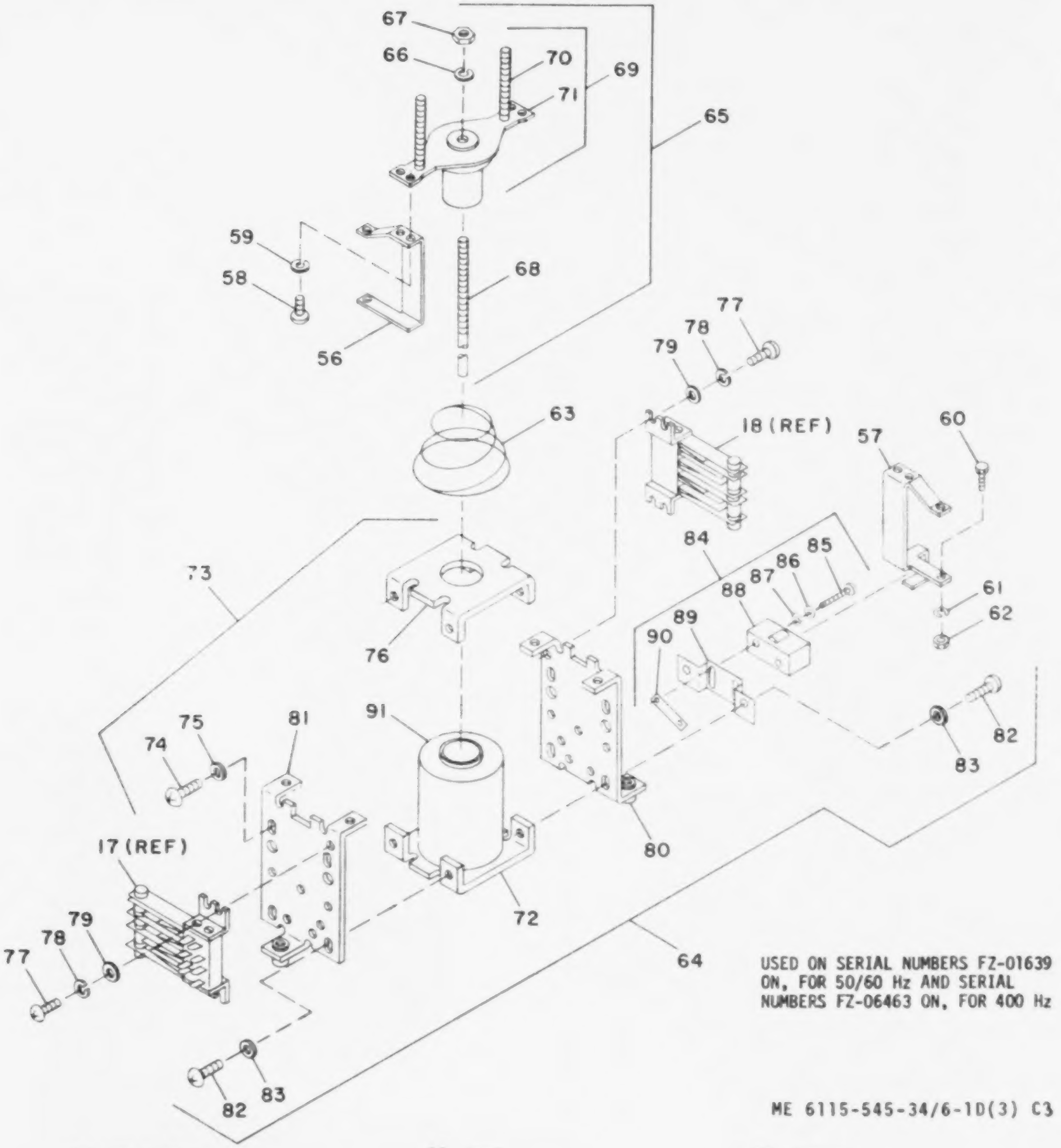
44
53

21. Locking spacer
22. Lock washer
23. Flat washer
24. Chamber
25. Gasket
26. Nut
27. Lock washer
28. Flat washer
29. Base assy
30. Screw
31. Lock washer
32. Flat washer
33. Flat washer
34. Nut
35. Bus bar
36. Insert
37. Base
38. Gasket
39. Nut
40. Lock washer
41. Flat washer
42. Spacer
43. Bushing
44. Bushing
45. Bridge assy
46. Housing
47. Bridge
48. Spring
49. Bushing
50. Arc chute
51. Screw
52. Lock washer
53. Metallic washer
54. Insulation
55. Detent

USED ON SERIAL NUMBERS FZ-01639 ON, FOR 50/60 Hz AND SERIAL NUMBERS FZ-06463 ON, FOR 400 Hz

ME 6115-545-34/6-1D(2) C3

Figure 6-1D. Main Load Contactor (Sheet 2 of 3)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18 (REF)
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84
85
86
87
88
61
62
89
90
76
91
81
75
74
82
83
80
17 (REF)
79
78
77
72
64
82
83

USED ON SERIAL NUMBERS FZ-01639 ON, FOR 50/60 Hz AND SERIAL NUMBERS FZ-06463 ON, FOR 400 Hz

ME 6115-545-34/6-1D(3) C3

56. Operator
57. Operator
58. Screw
59. Lock washer
60. Screw
61. Lock washer
62. Nut
63. Spring
64. Solenoid subassy
65. Moveable core-rod assy
66. Lock washer
67. Nut
68. Rod
69. Core assy
70. Stud
71. Operator
72. Frame-core assy
73. Frame assy
74. Screw
75. Flat washer
76. Frame
77. Screw
78. Lock washer
79. Flat washer
80. Frame
81. Frame
82. Screw
83. Flat washer
84. Micro switch assy
85. Screw
86. Lock washer
87. Flat washer
88. Switch
89. Bracket
90. Plate
91. Coil

Figure 6-1D. Main Load Contactor (Sheet 3 of 3)

## Section III. CURRENT TRANSFORMER

### 6-7. On Equipment Test.

a. The following resistance readings should be present for good current transformers. Use a Simpson 260 or equivalent meter, (properly zeroed) with the R x 1 scale selected for making the measurements.

b. Current transformer secondary resistance reading. (fig. 6-2)

| | | |
|---|---|---|
| Percent of Rated Load Meter | CT1 ... | 2.5 ohms |
| | CT2 ... | same as CT1 |
| | CT3 ... | same as CT1 |
| LMU | CT4 ... | 0.2 ohms pins 1 to 3, 0.1 ohm center pin to 1 and center pin to 3 |
| | CT5 ... | same as CT4 |
| | CT6 ... | same as CT4 |
| Cross Current Compensation | CT7 ... | 0.5 ohms pins 1 and 2 |

### 6-8. Removal and Disassembly.

a. Removal

(1) Remove and tag the generator output leads and pass them through the associated current transformers freeing the current transformer assembly for removal. (fig. 6-2)

(2) Remove the generator harness wiring from terminal block TB16, identifying each lead with the terminal block post number from which it was removed.

(3) Remove the current transformer assembly (7, fig. 6-3) by removing hardware items 3, 4 and 5.

b. Disassembly. See figure 6-4 and disassemble the current transformer as illustrated.

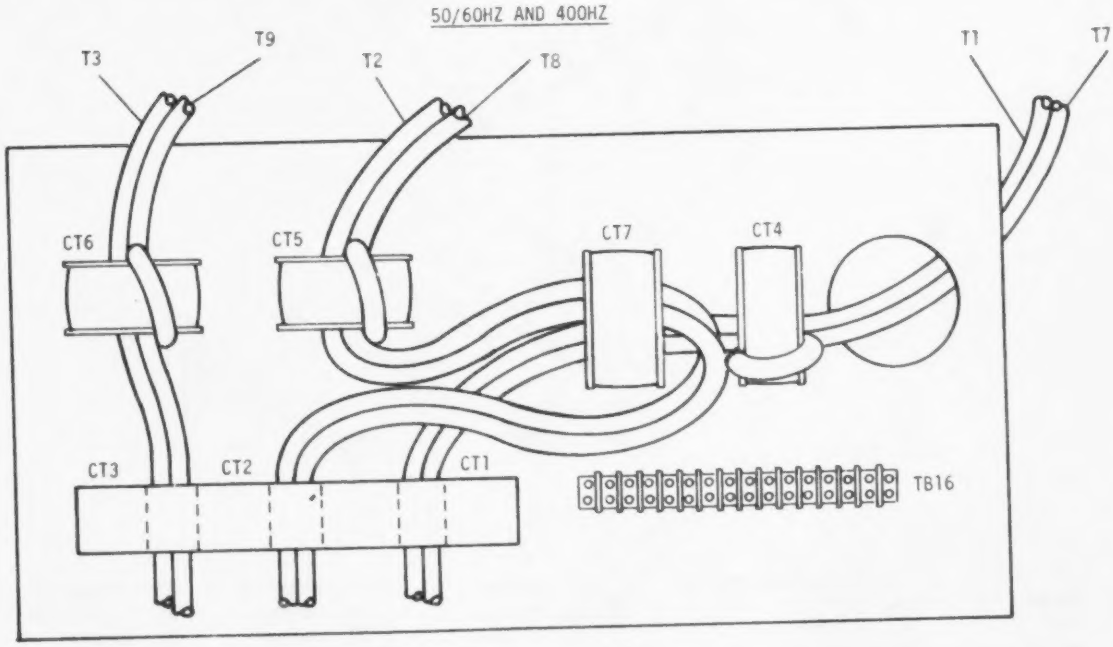

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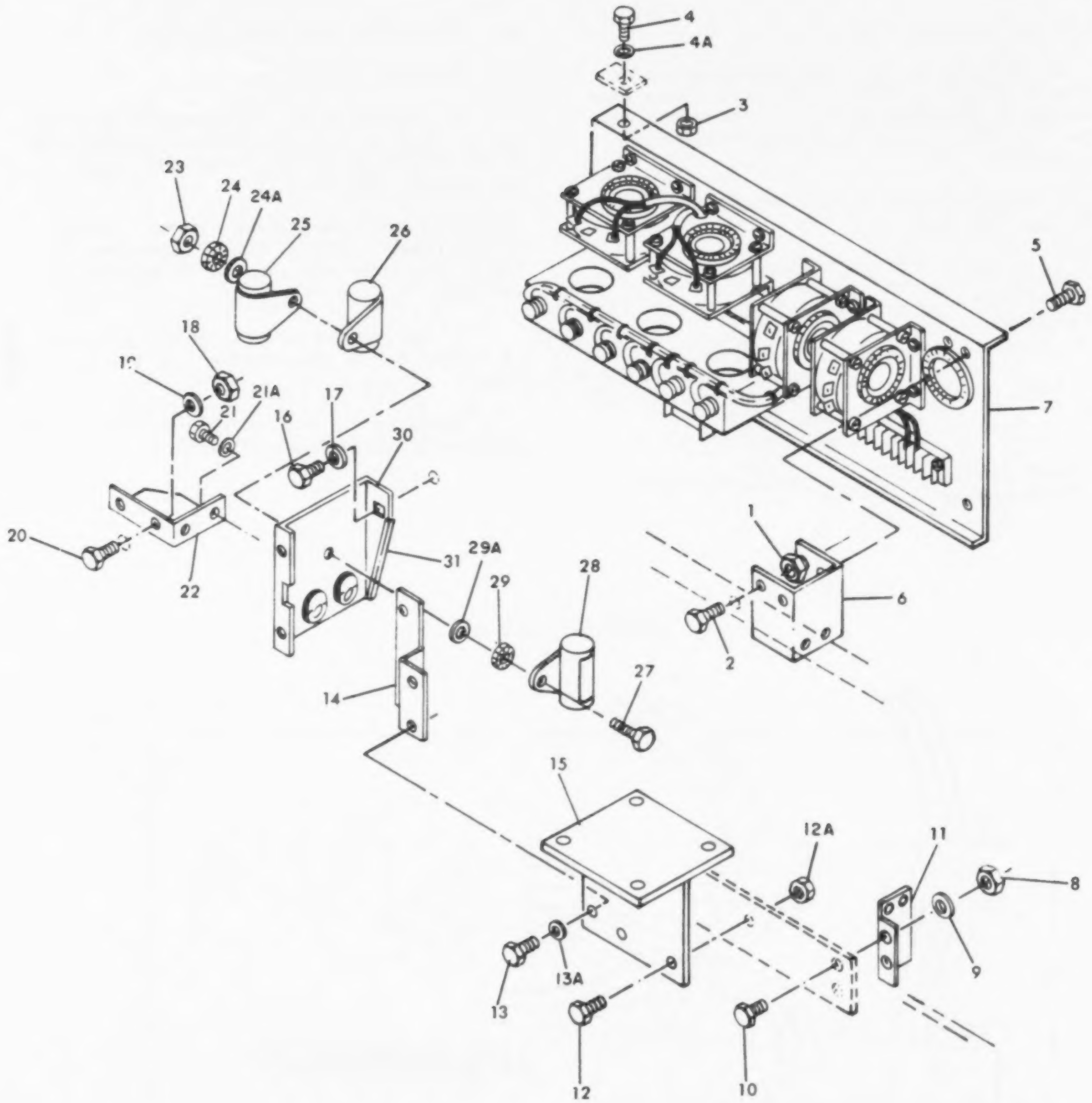
Figure 6-2. Routing Main Generator Leads Through Current Transformers



4
4A
3
23
24
24A
25
26
5
18
19
21A
17
21
16
30
7
20
22
31
29A
29
28
1
6
2
27
14
15
12A
11
8
9
13A
13
12
10

1. Nut
2. Screw
3. Nut
4. Screw
■ 4A. Washer
5. Screw
6. Bracket
7. Transformer assy
8. Nut
9. Washer
10. Screw
11. Bracket
12. Screw
■ 12A. Nut
13. Screw
■ 13A. Washer
14. Bracket
15. Bracket
16. Screw
17. Washer
18. Nut
19. Washer
20. Screw
21. Screw
■ 21A. Washer
22. Bracket
23. Nut
24. Washer
■ 24A. Washer
25. Capacitor
26. Capacitor
27. Screw
28. Capacitor
29. Washer
■ 29A. Washer
30. Bracket
31. Rubber channel

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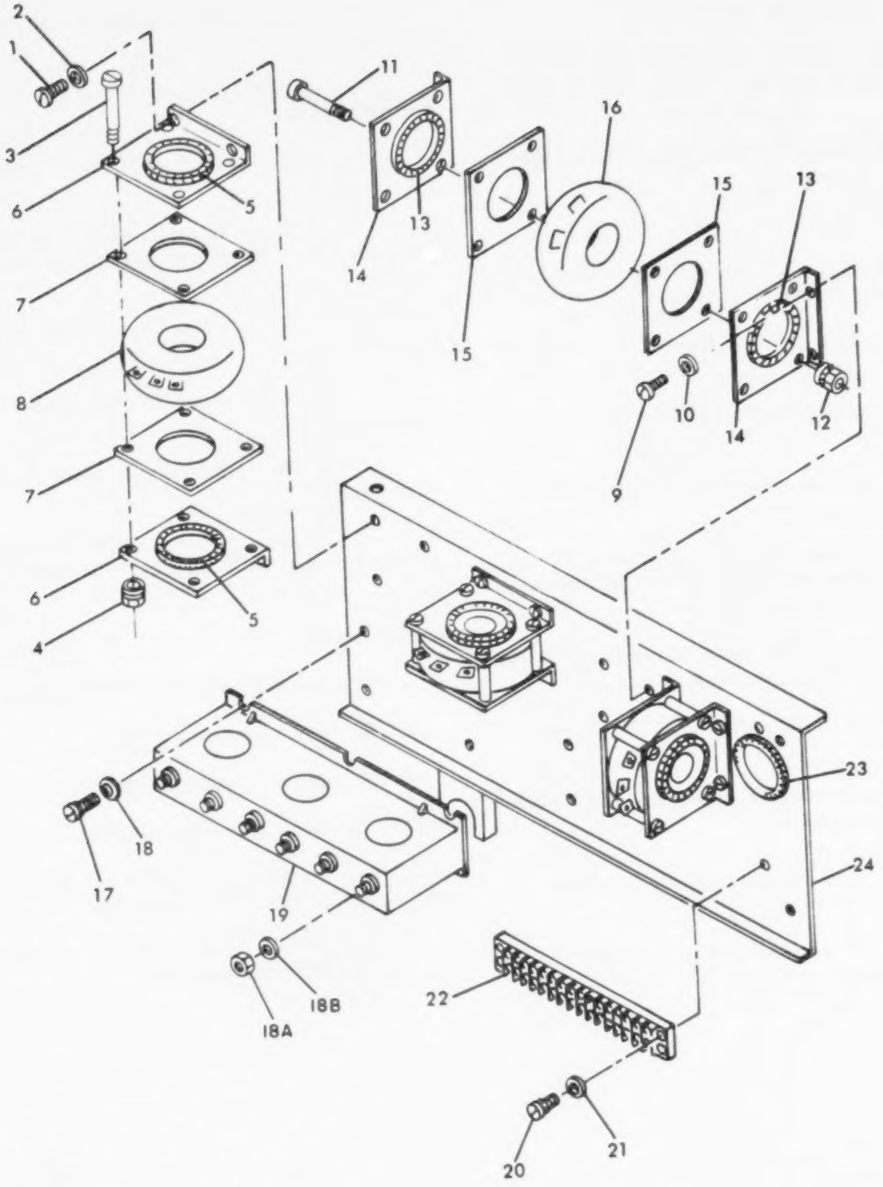
Figure 6-3. Current Transformer Assembly and Load Connecting Group Mounting Brackets


2
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7
6
5
4
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16
15
13
10
9
14
12
23
24
18
17
19
18B
18A
22
21
20

1. Screw
2. Washer
3. Screw
4. Nut
5. Grommet
6. Bracket
7. Gasket
8. Transformer (3)
9. Screw
10. Washer
11. Screw
12. Nut
13. Grommet
14. Bracket
15. Gasket
16. Transformer
17. Screw
18. Washer
18A. Nut
18B. Washer
19. Transformer
20. Screw
21. Washer
22. Terminal Board
23. Grommet
24. Panel

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Figure 6-4. Current Transformer Assembly

### 6-9. Cleaning, Inspection, and Testing.

a. Cleaning. Clean all components with a cloth dampened in cleaning solvent, Federal Specification P-D-680.

b. Inspection. Refer to Operator and Organizational Maintenance Manual.

c. Testing.

(1) To test CT1, CT2, and CT3 on either Mode I or Mode II sets, proceed as follows:

(a) Wrap 10 turns of a conductor around the coils of CT1.

(b) Apply an ac current of 10 amperes to the conductor.

(c) The current measured at terminals A1 and A2 must be 360 ma.

(d) Repeat steps (a) through (c) on CT2 and CT3. Measure CT2 at terminals B1 and B2; measure CT3 at terminals C1 and C2.

(2) To test CT4, CT5, and CT6 on either Mode I or Mode II sets, proceed as follows:

(a) Apply 20.7 volts (rms) 60 Hz across terminals 1 and 3.

(b) Voltage between terminals 1 and 2 shall measure 16.5 ± 1 percent Vac.

(c) Excitation current shall be less than 35 ma.

(d) Apply 50 amperes 60 Hz through 1 primary turn. Secondary current should be 180 ma ± 1% at terminals 1-3.

(3) To test CT7 on Mode II sets, proceed as follows:

(a) Apply 15 volts (rms) 400 Hz across, terminals 1 and 2.

(b) The excitation current shall be less than 45 ma (rms).

(c) Apply 50 amperes 400 Hz through 1 primary turn. Secondary current should be 250 ma ± 1%.

(4) To test CT7 on Mode I sets, proceed as follows:

(a) Apply 15 volts (rms) 60 Hz across terminals 1 and 2.

(b) Excitation current shall be less than 60 ma (rms).

(c) Apply 50 amperes 60 Hz through 1 primary turn. Secondary current should be 250 ma ± 1%.

### 6-10. Repair.

a. Replace defective current transformers.

b. Replace worn grommets.

c. Replace all gaskets with new ones.

### 6-11. Reassembly and Installation.

a. Reassembly. See figure 6-4 and reassemble the current transformer assembly.

b. Installation. See paragraph 6-8 and install the current transformer assembly.

# CHAPTER 7

## ELECTRO-HYDRAULIC GOVERNING SYSTEM (CLASS I, PRECISE SETS ONLY)

### 7-1. General

a. The electro-hydraulic governing system is a speed (frequency) sensing system used to maintain prime mover speed constant and therefore generator output frequency, during periods of unchanging load and when load additions or deletions occur.

b. The system consists of a control unit, load measuring unit and hydraulic throttle actuating unit.

c. The control unit inputs are the generator output voltage, and a dc voltage (0-9.8 Vdc) proportional to the generator load, supplied by the load measuring unit. The generator voltage input is applied to a frequency sensing network and reference voltage network. The differential output of these two networks determines the control current of two magnetic amplifiers whose outputs drive separate coils of the hydraulic actuators pilot valve. The actuator pilot valve positions the actuator power piston which is connected to the input arm of the fuel injection pump. The actuators hydraulic system is comprised of a reservoir, engine driven pump (300-320 psi, 2 gpm), cooler and filter.

d. Any deviation of engine speed, reflected as a change in frequency at the input of the governor, produces a change in the magnitude and direction of magnetic amplifier control field current. This change in control field current will increase the strength of one coil of the pilot valve while decreasing the strength of the other. The resultant difference repositions the pilot valve in turn repositioning the power piston which changes the output of the fuel injection pump, changing engine speed and consequently restoring generator frequency to its nominal value.

e. The load measuring units (LMU) input to the governor control provides for automatic load sharing when two or more sets are operated in parallel. Each set is equipped with an LMU.

f. If the load added to the system is not equally divided, the LMU inputs to their respective governors will differ. The resulting difference acting through additional windings of each sets governor (which are all connected in parallel) will reposition each sets actuator power piston such that fuel flow in the more heavily loaded set is decreased while that of the lightly loaded set is increased. Since the power input of each prime mover has been readjusted, equal division of true power (Kw) occurs with no deviation in frequency of any set.

### 7-2. Malfunction.

The following procedures are to be performed in the generator set unless otherwise specified.

a. If the FL - NL or NL - FL transient exceeds 1-1/2 percent of rated speed and/or does not re-establish stable engine operating conditions within one second, realign the control unit in accordance with paragraph 7-8 . Also follow this procedure if the engine speed hunts. If the set cannot be stabilized, check sockets A and B of plug P-21 (refer to Operator and Organizational Maintenance Manual) for 24 Vdc (A is positive).

b. If the engine speed increases to above nominal operating speed, check sockets A and B of P-17 for 120 Vac. If it is missing, troubleshoot the generator set wiring. (Refer to Operator and Organizational Maintenance Manual). If it is present, check the resistance of the frequency adjusting circuit consisting of R4 (250 ohms) rheostat R1 frequency adjust (500 ohms) and R5 (250 ohms) fixed resistor. Refer to Operator and Organizational Maintenance Manual. Measure the total circuit resistance across N and T of harness plug P17. The circuit resistance should be 1000 ohms (5 percent tolerance). After testing for correct total resistance, test the operation of the frequency adjust rheostat by connecting an ohmmeter across pins M and T and revolving the frequency adjust rheostat through its entire travel. The resistance should vary from 750 ohms to 250 ohms. Repeat this procedure using the ohmmeter across pins M and N of the harness plug. If the problem persists, check sockets A and B of plug P-21 for 24 Vdc (A is positive).

c. If the engine speed remains below the nominal operating speed, adjust R1. If there is no improvement, check the resistance of the frequency adjust circuit. Disconnect P-17 and check the resistance of the frequency adjust circuit consisting of R4 (250 ohms) fixed resistor, R1 frequency adjust rheostat (500 ohms) and R5 (250 ohms, 5 percent) fixed resistor. Refer to Operator and Organizational Maintenance Manual. Measure the total circuit resistance across N and T of harness plug P17. The circuit resistance should be 1000 ohms (5 percent tolerance). After testing for correct total resistance, test the operation of the frequency adjust potentiometer by connecting an ohmmeter across pins M and T and revolving the frequency adjust potentiometer through its entire travel. The resistance should vary from 750 ohms to 250 ohms. Repeat this procedure using the ohmmeter across pins M and N of the harness plug. Disconnect actuator electrical connector before making this measurement. Push actuator piston all the way down and adjust engine speed with manual throttle. If this value resistance is measured, check sockets A and B at plug P-21 for 24 Vdc (A is positive).

d. If the set is operating at a constant load and voltage and during an eight-hour period the change in ambient temperature does not exceed 60°F, the set frequency should not drift beyond 1/2 of one percent of rated frequency. The above requirement assumes that the set temperatures were stabilized at the initial and final ambient temperatures.

NOTE

> If the drift in paragraph d is excessive, realign the control unit following the procedure outlined in paragraph 7-8.

e. At constant ambient temperature, constant load, constant voltage and constant barometric pressure, the set frequency should remain within a bandwidth of 1 percent of rated frequency for a period of 4 hours. If this bandwidth has been exceeded, realign the control unit in accordance with paragraph 7-8.

f. If the preceding solutions to the specific problem do not resolve the problems, replace and repair the control unit, actuator (para 13-3 thru 13-8) or load measuring unit (para 8-15 thru 8-19) as required.

7-3. Removal.

Refer to figure 7-1 and remove in the order of sequence numbers.

7-4. Disassembly and Repair

a. Disassemble electric governor control unit, if required, as illustrated in figure 7-2.

NOTE

> Disassembly and repair of electric governor control unit at the field level is restricted to removal of the cover, connectors, potentiometers and test jacks. Further disassembly requires unpotting and the following disassembly can be performed by depot maintenance personnel only.

b. Remove cover and components installed on cover in the order of sequence numbers (1 thru 15).

NOTE

> Tag and unsolder wires for the components on the cover.

(1) Replace defective test jacks, potentiometers or connectors.

(2) Repair procedures for individual wires of a wiring harness are covered in the Operator and Organizational Maintenance Manual.

c. Remove six screws and lockwashers from cover of control unit. Lift cover slightly and set at a slight angle to keep the connectors and potentiometers out of the potting compound.

d. Place the complete unit in a temperature controlled oven, large enough to allow air to circulate completely around the unit.

CAUTION

> The melting temperature of the potting compound is 165°F. The flash point is 515°F. Do not unpot by placing unit on a hot plate type surface or by using an open flame.

e. Set the oven temperature at 180°F to 185°F and allow the unit to soak until the potting compound is melted. The normal soak period at this temperature is 11 to 12 hours.

WARNING

> Use care when handling the hot potting compound. It can cause severe injury to personnel.

f. Using heavy gloves and wearing safety glasses, remove the printed circuit board from the melted potting compound. Lift the board slowly, allowing the potting compound to drain off the components.

g. Set the printed circuit board with transformers on the bottom on a drain board and allow it to cool to room temperature.

h. Remove screw (4) and lockwashers (5) which attach connectors (P1, J3, P5, P2) to cover.

i. Tag wiring and remove harness (6).

j. Disassemble remaining components mounted on cover in accordance with index numbers 7 through 27.

7-5. Cleaning and Inspection.

a. Clean all parts with a cloth dampened in cleaning solvent Federal Specification P-D-680 and dry thoroughly.

b. Inspect for cracks, breaks, damaged connectors, damaged terminals, defective wiring, and defective components. Check potentiometer for continuity, resistance, and wiring for open insulation.

7-6 . Tests and Repair.

a. Perform test as outlined in figures 7-3 thru 7-10.

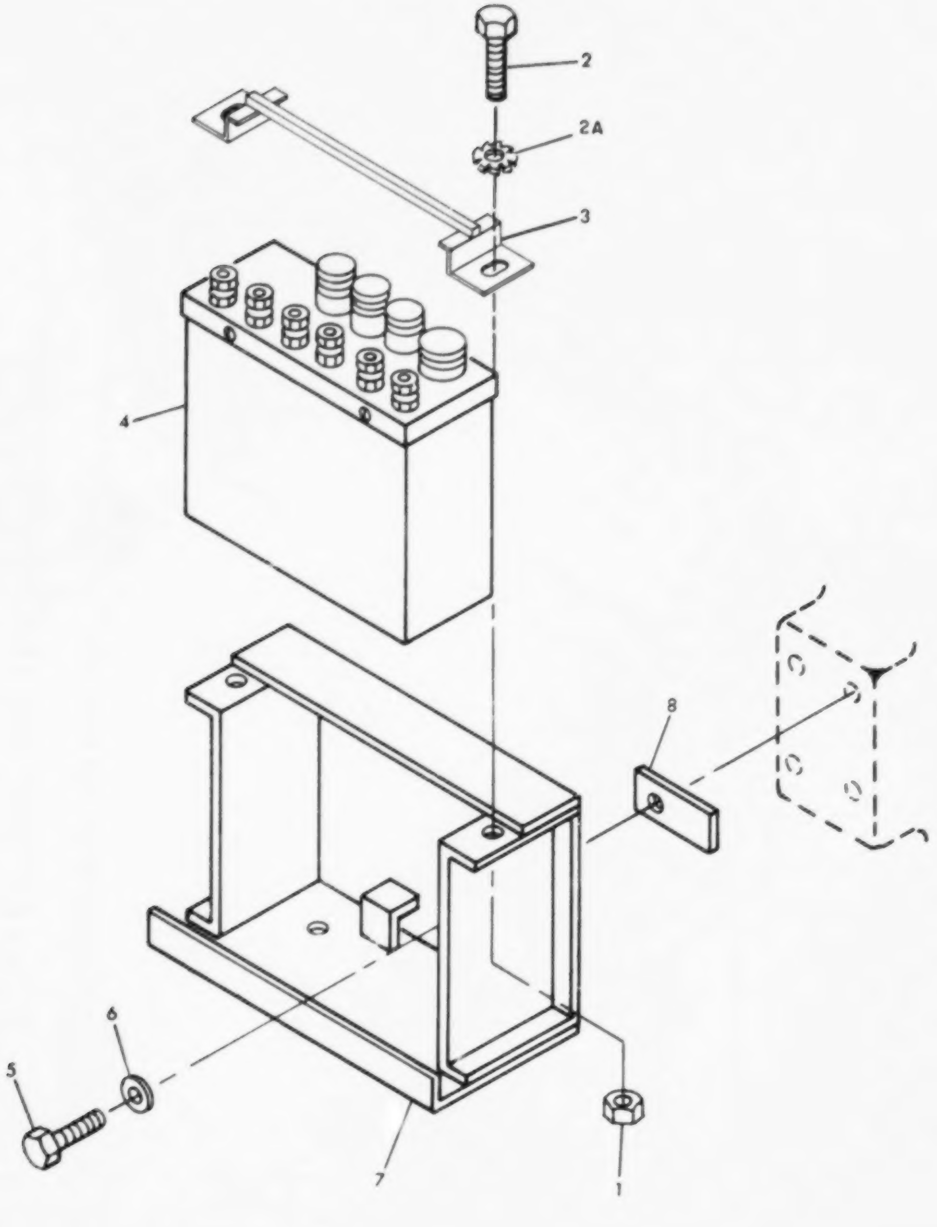
NOTE

> Mount circuit card as shown in figure 7-11 prior to test.

b. Resistance Test (50/60 Hz) . Refer to Table 7-1 and perform resistance test.

c. See figure 1-4 and 1-5 for schematic diagrams.

d. See table 7-2 for values of individual components. When measuring individual components, disconnect at least one lead to prevent feedback readings .



1. Nut
2. Screw
■ 2A. Washer
3. Holddown
4. Control unit
5. Screw
6. Washer
7. Bracket
8. Bracket

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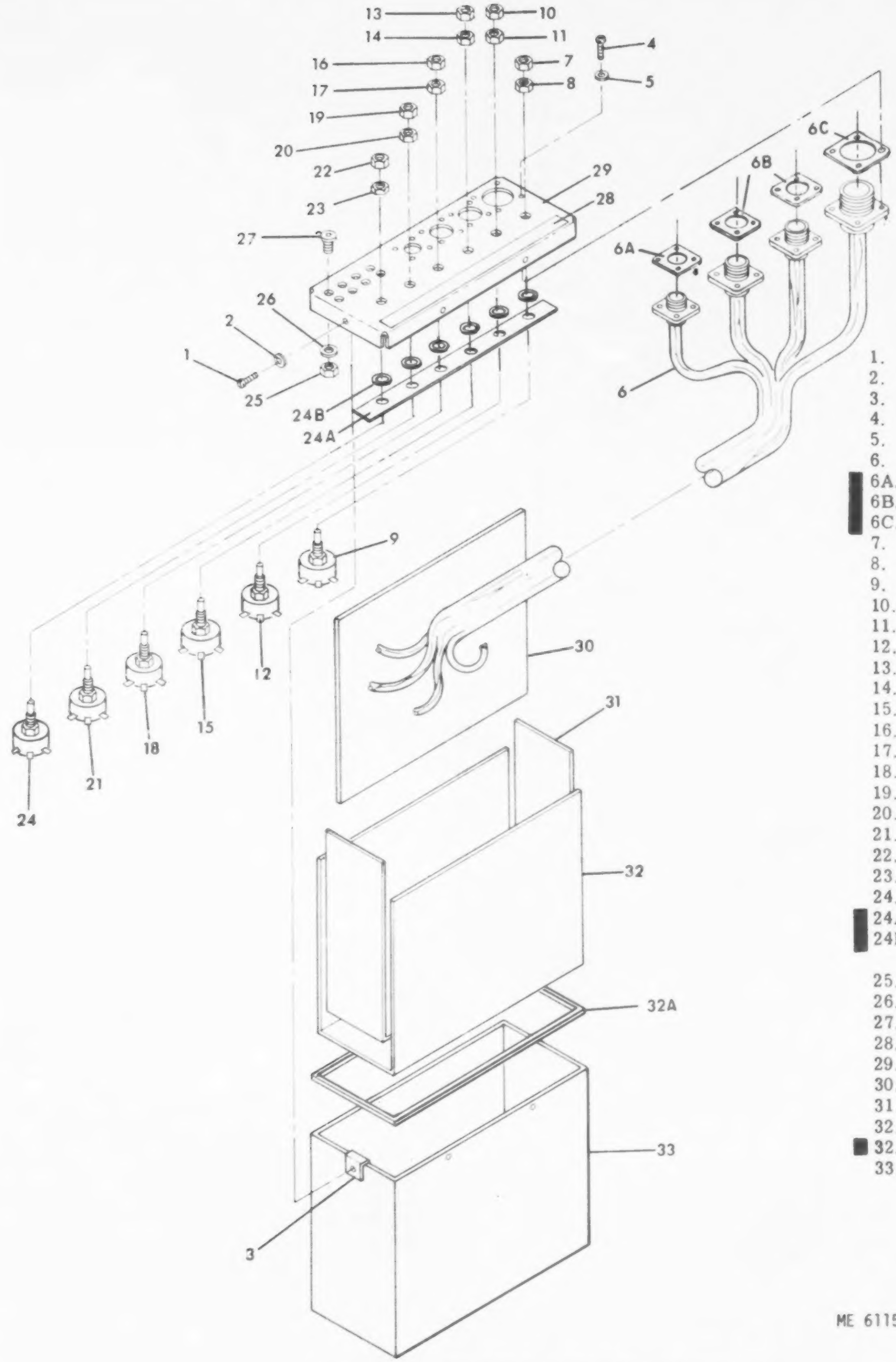
Figure 7-1. Electric Governor Control Unit Removal


13
14
10
11
4
5
16
17
7
8
19
20
6C
22
23
6B
29
28
27
6A
26
2
1
25
24B
24A
6
9
30
12
15
18
21
24
31
32
32A
33
3

|  |  |
|---|---|
| 1. | Screw |
| 2. | Washer |
| 3. | Nut, clip |
| 4. | Screw |
| 5. | Washer |
| 6. | Harness |
| 6A. | Gasket |
| 6B. | Gasket |
| 6C. | Gasket |
| 7. | Nut |
| 8. | Nut |
| 9. | Potentiometer |
| 10. | Nut |
| 11. | Nut |
| 12. | Potentiometer |
| 13. | Nut |
| 14. | Nut |
| 15. | Potentiometer |
| 16. | Nut |
| 17. | Nut |
| 18. | Potentiometer |
| 19. | Nut |
| 20. | Nut |
| 21. | Potentiometer |
| 22. | Nut |
| 23. | Nut |
| 24. | Potentiometer |
| 24A. | Spacer |
| 24B. | Washer, Sealing |
| 25. | Nut |
| 26. | Washer |
| 27. | Testjack |
| 28. | Nameplate |
| 29. | Panel |
| 30. | Circuit Board |
| 31. | Insulation |
| 32. | Insulation |
| 32A. | Gasket |
| 33. | Cabinet |

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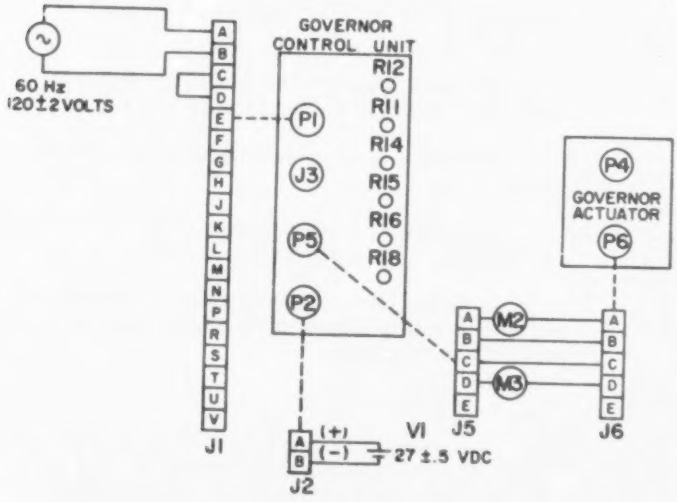
Figure 7-2. Electric Governor Control Unit

Table 7-1. Resistance Test (50/60 Hz)

| P1 Connection | Potentiometer Position | Nominal Resistance | Allowance resistance range (ohms) |
|---|---|---|---|
| T-N (T +) | | 5100 | 3400-6800 |
| M-N (M +) | | 2180 | 1950-2400 |
| (M +) | R18CCW | 12180 | 11000-13000 |
| F-N (F +) | | 6000 | 5000-7000 |
| (F +) | R16CCW | 31000 | 30000-32000 |
| (F +) | R15CCW | 6500 | 5500-7500 |
| E-G (E +) | | 5500 | 4500-6500 |
| R-G (R +) | | 120 | 100-140 |
| F-G (F + ) | | 650 | 550-750 |
| J-H (J +) | | LESS THAN 0.2 OHMS | |
| T-P (T +) | | 2200 | 1400-3000 |
| (T +) | R14CCW | 2600 | 1800-3400 |
| U-S (U + ) | | 525 | 450-600 |
| USING M1, MEASURE RESISTANCE OF EACH PIN (ALL CONNECTORS) AND EACH TEST POINT TO GOVERNOR CONTAINER. RESISTANCE SHOULD BE INFINITY ON 100,000 OHM SCALE. REPEAT FOR REVERSE POLARITY. RESISTANCE SHOULD BE INFINITY ON 100,000 OHM SCALE. | | | |


60 Hz
120±2 VOLTS
A
B
C
D
E
F
G
H
J
K
L
M
N
P
R
S
T
U
V
J1
GOVERNOR CONTROL UNIT
R12
R11
R14
R15
R16
R18
P1
J3
P5
P2
A
B
J2
(+)
(-)
V1
27 ±.5 VDC
J5
M2
M3
J6
P4
GOVERNOR ACTUATOR
P6

MAGNETIC AMPLIFIER BIAS TEST

TURN R11, R12, R14, R15, R16, R18 FULL CW.

CONNECT GOVERNOR CONTROL UNIT TO TEST EQUIPMENT AS SHOWN.

ADJUST R11 AND R12 FOR BALANCED READING OF 450 MA ON M2 AND M3.

TURN R12 FULL CW. M2 AND M3 SHALL READ 0-300 MA, AND BE BALANCED WITHIN 50 MA.

TURN R12 FULL CCW. M2 AND M3 SHALL READ 600-1000 MA, AND BE BALANCED WITHIN 50 MA.

READJUST R11 AND R12 FOR BALANCED READING OF 450 MA ON M2 AND M3. LOCK R11 AND R12 FOR REMAINDER OF TEST.

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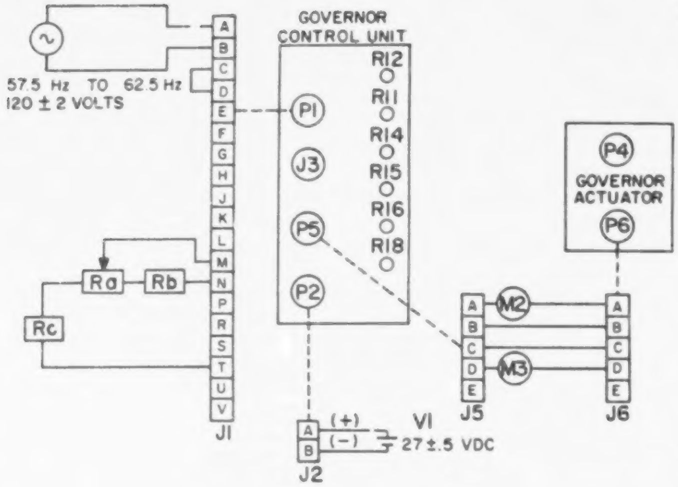
Figure 7-3. Electric Governor Control Unit, Magnetic Amplifier Bias Test (50/60 Hz)



FREQUENCY SENSING CHECK (HIGH AND LOW FREQUENCY)

CONNECT GOVERNOR CONTROL UNIT TO TEST EQUIPMENT AS SHOWN

TURN Ra SO THE RESISTANCE BETWEEN P1-M AND P1-T IS 250 OHMS.

REDUCE THE FREQUENCY OF THE APPLIED 120 ± 2 VOLT SUPPLY UNTIL M2 AND M3 BALANCE.

THE FREQUENCY SHALL BE 57 - 58 Hz.

TURN Ra SO THE RESISTANCE BETWEEN P1-M AND P1-N IS 250 OHMS.

INCREASE THE FREQUENCY OF THE APPLIED 120 ± 2 VOLT SUPPLY UNTIL M2 AND M3 BALANCE.

THE FREQUENCY SHALL BE 64 - 65 Hz.

TEST EQUIPMENT

| REF DES | QUANTITY | DESCRIPTION |
|---|---|---|
| Ra | 1 | POTENTIOMETER, 10 TURN, 500 OHM, 5 WATT |
| Rb, Rc | 2 | RESISTOR, FIXED, 250 OHM, 5 WATT |
| M2, M3 | 2 | MILLIAMMETER, DC, 0-1000 MA |
| V1 | 1 | DC POWER SOURCE |
| ∿ | 1 | AC POWER SOURCE |

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Figure 7-4. Electric Governor Control Unit, Frequency Sensing Check (High and Low Frequency) (50/60 Hz)

e. Magnetic Amplifier Bias Test (50/60 Hz). Refer to figure 7-3 and perform the magnetic amplifier bias test.

f. Frequency Sensing Check, High and Low Frequency (50/60 Hz). Refer to figure 7-4 and perform the frequency sensing check.

g. Rectifier Bridge, CR7 thru CR10 and Feedback Winding Test (50/60 Hz). Refer to figure 7-5 and perform the rectifier bridge and feedback winding test.

h. Parallel Winding Test (50/60 Hz). Refer to figure 7-6 and perform the parallel winding test.

i. Resistance Test (400 Hz). Refer to Table 7-3 and perform resistance test.

j. Magnetic Amplifier Bias Test (400 Hz). Refer to figure 7-7 and perform the magnetic amplifier bias test.

k. Frequency Sensing Check, High and Low Frequency (400 Hz). Refer to figure 7-8 and perform the frequency sensing check.

l. Rectifier Bridge, CR7 thru CR10 and Feedback Winding Test (400 Hz). Refer to figure 7-9 and perform the rectifier bridge and feedback winding test.

m. Parallel Winding Test (400 Hz). Refer to figure 7-10 and perform the parallel winding test.

n. Replace any component found to be defective during tests.

o. For wiring harness repairs, refer to Operator and Organizational Maintenance Manual.

p. If wiring harness has sustained extensive damage, refer to Chapter 5 for wiring harness rebuilding procedures.

### 7-7. Assembly.

a. See figure 7-12 and assemble printed circuit board. If any connections are opened or bared for test purposes, or if any defective components are replaced, the effected area and components must be coated with polyurethane resin to prevent oxidation or other corrosion . The coating must be of a minimum thickness of 0.007 inches and air bubble entry into the applied polyurethane must be controlled so that the legibility of component coding and identification is not impaired. The polyurethane resin to be utilized will correspond to MIL-I-46058,

Table 7-2. Electric Governor Control Unit Component Values

| Component | 50/60 Hz Unit (ohms) | 400 Hz Unit (ohms) | Remarks |
|---|---|---|---|
| R1, R1A, R15 | 500 | 500 | 3.0% tolerance |
| R11 | 5000 | 5000 | |
| R4, R8, R22 | 5100 | 5100 | 3.0% tolerance |
| R37 | 5100 | 3500 | |
| R2, R10 | 1250 | 750 | 3.0% tolerance |
| R12, R18 | 10,000 | 10,000 | 3.0% tolerance |
| R16 | 25,000 | 25,000 | 3.0% tolerance |
| R14, R20 | 3,000 | 3,000 | 3.0% tolerance |
| Parallel winding | Less than 1.0 (nominal) | Less than 1.0 (nominal) | Check for open |
| Feedback winding | Less than 1.0 (nominal) | Less than 1.0 (nominal) | Check for open |
| Frequency control winding | Less than 1.0 (nominal) | Less than 1.0 (nominal) | Check for open |
| Bias control winding | Less than 1.0 (nominal) | Less than 1.0 (nominal) | Check for open |

Grade S, Type PUR.

b. See figure 7-2 and reassemble control unit components.

c. Reconnect cover to printed circuit board with wiring harness.

d. Place the container in a temperature controlled oven. Set oven temperature at 180 to 185°F and allow container to soak 11 to 12 hours or until potting compound is completely melted.

e. Prior to installing the printed circuit board, remove the container from the oven and make sure that insulation paper is positioned next to the container shell.

f. Using heavy gloves, and safety glasses slowly lower the printed circuit board into the potting compound.

WARNING

Use care not to splash hot potting compound on operating personnel. It can cause severe injury.

g. Position the printed circuit board and allow compound to cool.

h. When compound has cooled and is substantially solid, install top cover and hardware.

7-8. Adjustment.

See figure 7-13 for location of adjustment and controls and adjust electric governor according to the following procedures:

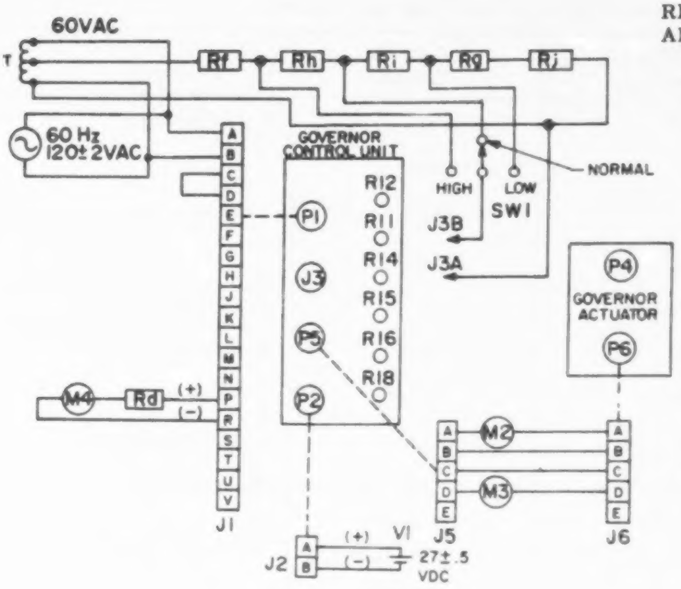
a. Single Set Adjustment Procedures

(1) With engine not operating, set frequency adjust control (on control panel), R11, R14, R16, and R18 to midpoint by turning full each way and approximating center. Set R15 full counterclockwise and R12 approximately 1/4 clockwise.

(2) Start engine. Refer to Operator and Organizational Maintenance Manual for operating instructions. If engine hunts, perform following adjustments to stabilize operation:

(a) If hunt is of high frequency and small amplitude, adjust R12 clockwise and/or R16 counterclockwise.

(b) If hunt is of low frequency and long amplitude, adjust R18 counterclockwise. If operation does not stabilize, turn R16 clockwise. It may be necessary to adjust R12 counterclockwise in conjunction with R18 and R16 adjustments to stabilize operation.



**RECTIFIER BRIDGE, CR7 THRU CR10 AND FEEDBACK WINDING TEST.**

CONNECT GOVERNOR CONTROL UNIT TO TEST EQUIPMENT AS SHOWN

TURN R14 CCW, R15 CCW.

M4 SHOULD READ -5 TO -7MA.

ADJUST R14 CW TO BALANCE M2 AND M3.

TURN SW1 TO "LOW"
M2 SHALL READ 600-840MA.
M3 SHALL READ 0-300 MA.
M4 SHALL READ 0 TO +1.5 MA.

TURN SW1 TO "HIGH"
M2 SHALL READ 0-300 MA.
M3 SHALL READ 600-840 MA.
M4 SHALL READ 0 TO -1.5 MA.

TEST EQUIPMENT

| REF DES | QUANTITY | DESCRIPTION |
|---|---|---|
| Rd | 1 | RESISTOR, FIXED, 5000 OHMS, 1 WATT |
| Rf, Rg | 2 | RESISTOR, FIXED, B2 OHM, 10 WATT |
| Rh, Ri | 2 | RESISTOR, FIXED, 15 OHMS, 5 WATT |
| Rj | 1 | RESISTOR, FIXED, 25 OHMS, 5 WATT |
| M2, M3 | 2 | MILLIAMMETER, DC, 0-1000 MA |
| M4 | 1 | MILLIAMMETER, DC, ZERO CENTER, 10-0-10 MA |
| Swl | 1 | SWITCH, ROTARY, 3 POSITION, 1 POLE, 1 AMP |
| V1 | 1 | DC POWER SOURCE |
| ⏦ | 1 | AC POWER SOURCE |
| T | 1 | AUTOTRANSFORMER 2:1 RATIO |

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Figure 7-5. Electric Governor Control Unit, Rectifier Bridge and Feedback Winding Test (50/60 Hz)

(3) Once the set has been stabilized, connect a 0 - 10 volt range dc voltmeter (high impedance type - 2000 ohms per volt or more) across test points 3 and 4 with the positive lead at test point 4. Adjust FREQUENCY ADJUST control to obtain operating frequency (400 Hz, or 60 Hz), and then adjust R14 until voltage across test points 3 and 4 is zero volts, with no load on generator.

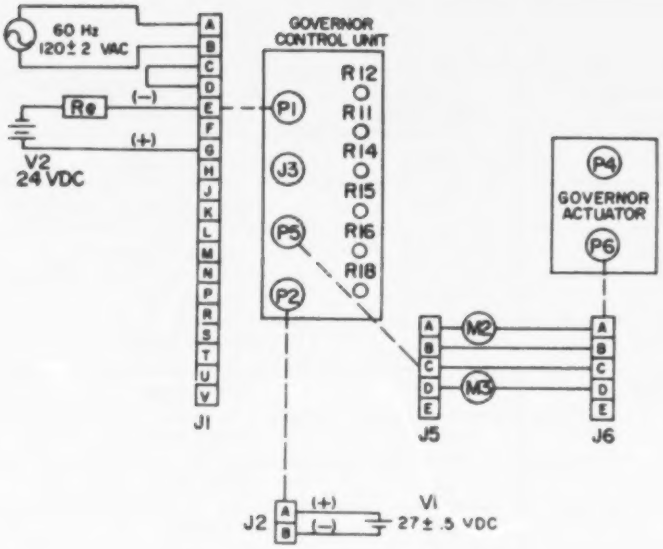
(4) Connect dc voltmeter across tests points 1 and 2 with positive lead at test point 1. Adjust R11 and the frequency adjust control until the dc voltmeter reads zero volts at nominal frequency. Repeat the adjustment until the voltage across test points 3 and 4 and across 1 and 2 is zero volts, and the set frequency is 50 Hz, 60 Hz or 400 Hz with no load on the engine. If test points 1 and 2 cannot be zeroed, they must be reduced to a minimum.

(5) Adjust R12 until a reading of approximately 4.5 volts is obtained across test points A and B, with no load on generator. If this voltage is too low, response will be sluggish and if it is too high, a rapid oscillation may occur. Normal range is 3 to 6 volts.

(6) Adjust R18 clockwise as far as possible, and R16 counterclockwise as far as possible without causing oscillation.

NOTE

Increasing the load measurement gain R15 (turning in a clockwise direction) will improve transient performance; therefore, it should be adjusted as high as possible. Transient performance must be checked using a frequency recorder.



PARALLEL WINDING TEST

CONNECT GOVERNOR CONTROL UNIT TO TEST EQUIPMENT AS SHOWN.

M2 SHALL READ 0-300 MA.
M3 SHALL READ 600-840 MA.

REVERSE POLARITY OF CONNECTIONS TO PINS J1-E AND J1-G.

M2 SHALL READ 600-840 MA.
M3 SHALL READ 0-300 MA.

TEST EQUIPMENT

| REF DES | QUANTITY | DESCRIPTION |
|---|---|---|
| Re | 1 | RESISTOR, FIXED, 50,000 OHMS, 10 WATT |
| M2, M3 | 2 | MILLIAMMETER, DC, 0-1000 MA |
| V1 | 1 | DC POWER SOURCE |
| V2 | 1 | DC POWER SOURCE |
| ⊝ | 1 | AC POWER SOURCE |

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Figure 7-6. Electric Governor Control Unit Parallel Winding Test (50/60 Hz)

(7) The adjustment of R18 and R16 are interdependent. For any position of R18 there is an optimum position for R16. Therefore, to improve transient performance, increase the frequency gain by turning R18 clockwise. If hunt develops, readjust R16 for stability. If no hunt develops, apply and reject load on the generator set to check for stability under transient conditions. Assuming that no hunt develops for an increase in frequency gain, (R18 turned clockwise) or that hunt can be removed by readjustment of R16, again increase frequency gain by turning R18 clockwise and note the transient performance. Finally a position may be reached where no readjustment of R16 can stabilize for the high frequency gain of R18. Then reduce the frequency gain to the stable region and optimize stability and performance with R16. The frequency gain should be reduced to a point where the system is not on the edge of instability for long-term stable operation.

(8) Transient performance improves as the frequency gain R18 is increased and the feedback gain R16 is a minimum for that particular position of frequency gain adjustment. If R16 is adjusted too far counterclockwise, there will be insufficient feedback to stabilize the operation at steady state. If a slow oscillation occurs, turn R16 clockwise until stability is reached. This is the optimum setting for the level of frequency gain.

(9) If R16 is turned far clockwise, a very fast oscillation may occur. Turn R16 counterclockwise to the optimum point of stabilitv.

b. Parallel Operation (Class 1 sets)

(1) Adjust in accordance with paragraph 16-11.

(2) If the sets will not divide load, or if they oscillate (successively interchange load) on the first attempt to parallel, check the polarity across pin A and B of the parallel receptacle on both sets and verify, that the input circuits to pin C and D are correct and that the voltages are as specified.

7-9. Equipment Test

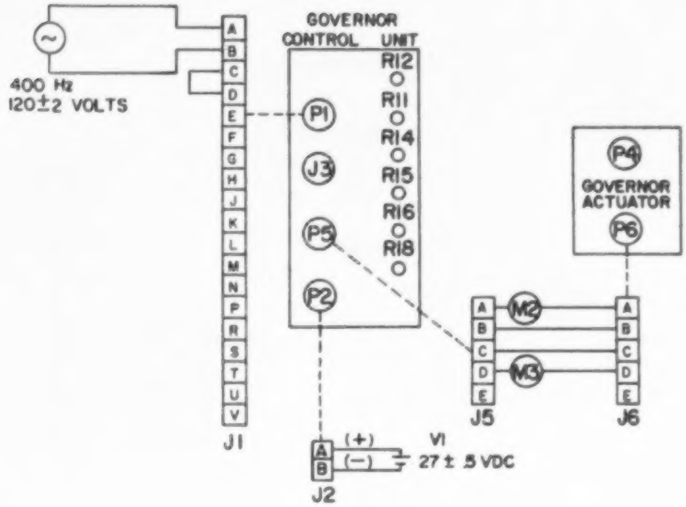
If the electric governor control has been renewed or repaired, refer to Chapter 16, Section II and conduct the following tests.

a. Frequency and voltage regulation, stability and transient response test, short term. (para 16-15)

b. Frequency adjustment range test (para 16-16)

## Table 7-3. Resistance Test (400 Hz)

| P1 Connection | Potentiometer Position | Nominal Resistance | Allowable resistance range (ohms) |
|---|---|---|---|
| T-N (T +) | | 2550 | 2300-3200 |
| M-N (M +) | | 1400 | 1200-1700 |
| (M +) | R18CCW | 11480 | 10000-12000 |
| F-N (F + ) | | 4160 | 3500-5500 |
| (F +) | R16CCW | 29160 | 27000-31000 |
| (F +) | R15CCW | 4660 | 4000-5500 |
| E-G (E +) | | 5500 | 4500-6500 |
| R-G (R + ) | | 120 | 100-140 |
| F-G (F +) | | 650 | 550-750 |
| J-H (J +) | | LESS THAN 0.2 OHMS | |
| T-P (T +) | | 1950 | 1400-2500 |
| (T +) | R14CCW | 2150 | 1500-2800 |
| U-S (U +) | | 520 | 450-600 |
| USING M1, MEASURE RESISTANCE OF EACH PIN (ALL CONNECTORS) AND EACH TEST POINT TO GOVERNOR CONTAINER. RESISTANCE SHOULD BE INFINITY ON 100,000 OHM SCALE. REPEAT FOR REVERSE POLARITY. RESISTANCE SHOULD BE INFINITY ON 100,000 OHM SCALE. | | | |


400 Hz
120±2 VOLTS
A
B
C
D
E
F
G
H
J
K
L
M
N
P
R
S
T
U
V
J1
GOVERNOR
CONTROL UNIT
R12
R11
R14
R15
R16
R18
P1
J3
P5
P2
P4
GOVERNOR
ACTUATOR
P6
M2
M3
A
B
C
D
E
J5
A
B
C
D
E
J6
(+)
(−)
V1
27 ± .5 VDC
A
B
J2

### MAGNETIC AMPLIFIER BIAS TEST.

TURN R11, R12, R14, R15, R16, R18 FULL CW.

CONNECT GOVERNOR CONTROL UNIT TO TEST EQUIPMENT AS SHOWN.

ADJUST R11 AND R12 FOR BALANCED READING OF 450 MA ON M2 AND M3.

TURN R12 FULL CW. M2 AND M3 SHALL READ 0-300 MA, AND BE BALANCED WITHIN 50 MA.

TURN R12 FULL CCW. M2 AND M3 SHALL READ 600-1000 MA, AND BE BALANCED WITHIN 50 MA.

READJUST R11 AND R12 FOR BALANCED READING OF 450 MA ON M2 AND M3 AND LOCK R11 AND R12 FOR REMAINDER OF TEST.

TEST EQUIPMENT

| REF DES | QUANTITY | DESCRIPTION |
|---|---|---|
| M2, M3 | 2 | MILLIAMMETER, DC, 0-1000 MA |
| V1 | 1 | DC POWER SOURCE |
| (~) | 1 | AC POWER SOURCE |

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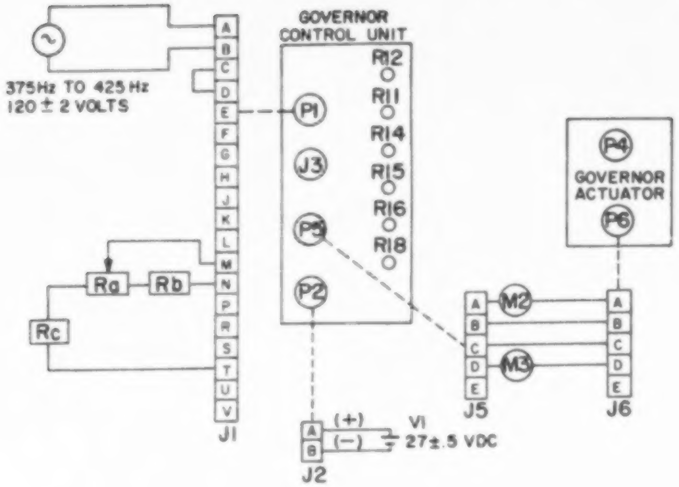
Figure 7-7. Electric Governor Control Unit, Magnetic Amplifier Bias Test (400 Hz)


GOVERNOR
CONTROL UNIT
375Hz TO 425 Hz
120 ± 2 VOLTS
A
B
C
D
E
F
G
H
J
K
L
M
N
P
R
S
T
U
V
J1
Ra
Rb
Rc
P1
J3
P5
P2
R12
R11
R14
R15
R16
R18
P4
GOVERNOR
ACTUATOR
P6
M2
M3
J5
J6
(+)
(−)
V1
27±.5 VDC
J2

FREQUENCY SENSING CHECK (HIGH AND LOW FREQUENCY)

CONNECT GOVERNOR CONTROL UNIT TO TEST EQUIPMENT AS SHOWN

TURN Ra SO THE RESISTANCE BETWEEN P1-M AND P1-T IS 250 OHMS.

REDUCE THE FREQUENCY OF THE APPLIED 120± 2 VOLT SUPPLY UNTIL M2 AND M3 BALANCE.

THE FREQUENCY SHALL BE 375 - 380 Hz.

TURN Ra SO THE RESISTANCE BETWEEN P1-M AND P1-N IS 250 OHMS.

INCREASE THE FREQUENCY OF THE APPLIED 120 ± 2 VOLT SUPPLY UNTIL M2 AND M3 BALANCE.

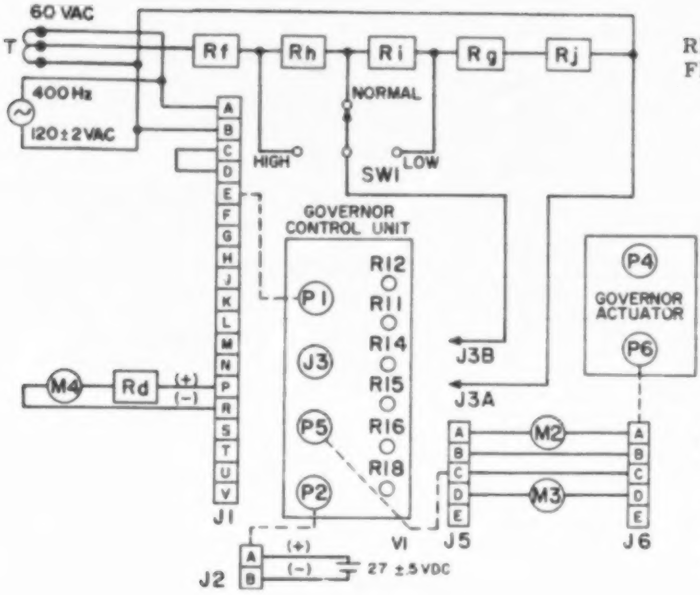
THE FREQUENCY SHALL BE 420 - 425 Hz.

TEST EQUIPMENT

| REF DES | QUANTITY | DESCRIPTION |
|---|---|---|
| Ra | 1 | POTENTIOMETER, 10 TURN, 500 OHMS, 5 WATT |
| Rb, Rc | 2 | RESISTOR, FIXED, 250 OHMS, 5 WATT |
| M2, M3 | 2 | MILLIAMMETER, DC, 0-1000 MA |
| V1 | 1 | DC POWER SOURCE |
| ~ | 1 | AC POWER SOURCE |

ME 6115-545-34/7-8

Figure 7-8. Electric Governor Control Unit, Frequency Sensing Check (400 Hz)


60 VAC
T
400 Hz
120±2VAC
Rf
Rh
Ri
Rg
Rj
NORMAL
HIGH
SW1
LOW
A
B
C
D
E
F
G
H
J
K
L
M
N
P
R
S
T
U
V
J1
GOVERNOR CONTROL UNIT
P1
J3
P5
P2
R12
R11
R14
R15
R16
R18
J3B
J3A
V1
J5
J6
M4
Rd
(+)
(-)
M2
M3
P4
GOVERNOR ACTUATOR
P6
J2
27 ±.5 VDC

RECTIFIER BRIDGE, CR7 THRU CR10, AND FEEDBACK WINDING TEST.

CONNECT GOVERNOR CONTROL UNIT TO TEST EQUIPMENT AS SHOWN IN FIGURE 3.

TURN R14 CCW, R15 CCW.

M4 SHOULD READ -5 TO -7 MA.

ADJUST R14 CW TO BALANCE M2 AND M3.

TURN SW1 TO "LOW".
M2 SHALL READ 600-840 MA.
M3 SHALL READ 0-300 MA.
M4 SHALL READ 0 TO +1.5 MA.

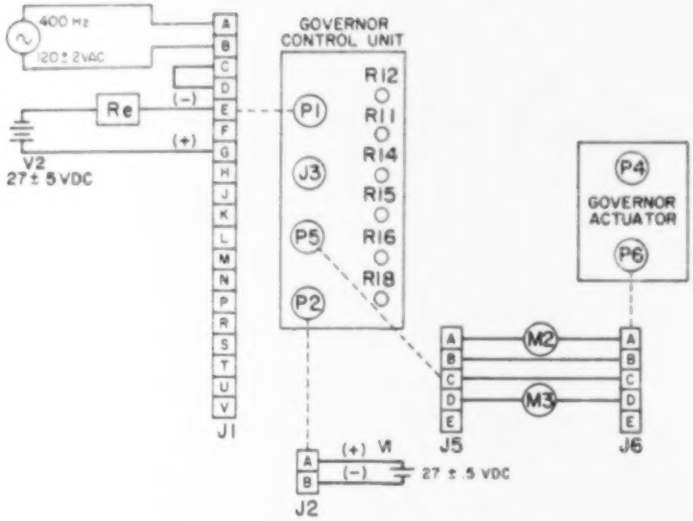
TURN SW1 TO "HIGH".
M2 SHALL READ 0-300 MA.
M3 SHALL READ 600-840 MA.
M4 SHALL READ 0 TO -1.5 MA.

TEST EQUIPMENT

| REF DES | QUANTITY | DESCRIPTION |
|---|---|---|
| Ra | 1 | POTENTIOMETER, 10 TURN, 500 OHMS, 5 WATT |
| Rb, Rc | 2 | RESISTOR, FIXED, 250 OHMS, 5 WATT |
| Rd | 1 | RESISTOR, FIXED' 5000 OHMS, 1 WATT |
| Re | 1 | RESISTOR, FIXED, 50,000 OHMS, 10 WATT |
| Rf, Rg | 2 | RESISTOR, FIXED, 32 OHMS, 10 WATT |
| Rh, Ri | 2 | RESISTOR, FIXED, 15 OHMS, 5 WATT |
| Rj | 1 | RESISTOR, FIXED, 25 OHMS, 5 WATT |
| M1 | 1 | OHMMETER, 100,000 OHMS SCALE |
| M2, M3 | 2 | MILLIAMMETER, DC, 0-1000 MA |
| M4 | 1 | MILLIAMMETER, DC, ZERO CENTER, 10-0-10 MA |
| SW1 | 1 | SWITCH, ROTARY, 3 POSITION, 1 POLE, 1 AMP |
|  | 1 | GOVERNOR ACTUATOR, P/N 13217E5390 |
| V1 | 1 | DC POWER SOURCE |
| V2 | 1 | DC POWER SOURCE |
| ~ | 1 | AC POWER SOURCE |
| T | 1 | AUTOTRANSFORMER 2:1 RATIO |

ME 6115-545-34/7-9

Figure 7-9 . Electric Governor Control Unit, Rectifier Bridge and Feedback Winding Test (400 Hz)


400 Hz
120 ± 2VAC
Re
(-)
(+)
V2
27 ± 5 VDC
A
B
C
D
E
F
G
H
J
K
L
M
N
P
R
S
T
U
V
J1
GOVERNOR
CONTROL UNIT
P1
J3
P5
P2
R12
R11
R14
R15
R16
R18
GOVERNOR
ACTUATOR
P4
P6
M2
M3
J5
J6
(+) V1
(-)
27 ± .5 VDC
J2

PARALLEL WINDING TEST.

CONNECT GOVENOR CONTROL UNIT TO TEST EQUIPMENT AS SHOWN

M2 SHALL READ 0-300 MA.
M3 SHALL READ 600-840 MA.

REVERSE POLARITY OF CONNECTIONS TO PINS J1-E AND J1-G.

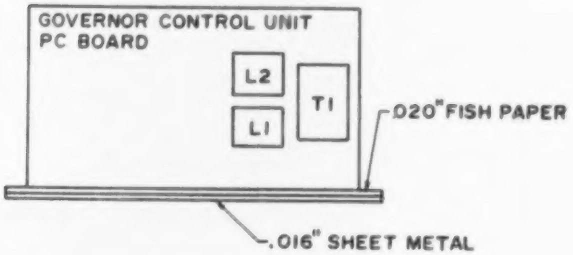
M2 SHALL READ 600-840 MA.
M3 SHALL READ 0-300 MA.

TEST EQUIPMENT

| REF DES | QUANTITY | DESCRIPTION |
|---|---|---|
| Re | 1 | RESISTOR, FIXED, 50,000 OHMS, 10 WATT |
| M2, M3 | 2 | MILLIAMMETER, DC, 0-1000 MA |
| V1 | 1 | DC POWER SOURCE |
| V2 | 1 | DC POWER SOURCE |
| ∿ | 1 | AC POWER SOURCE |

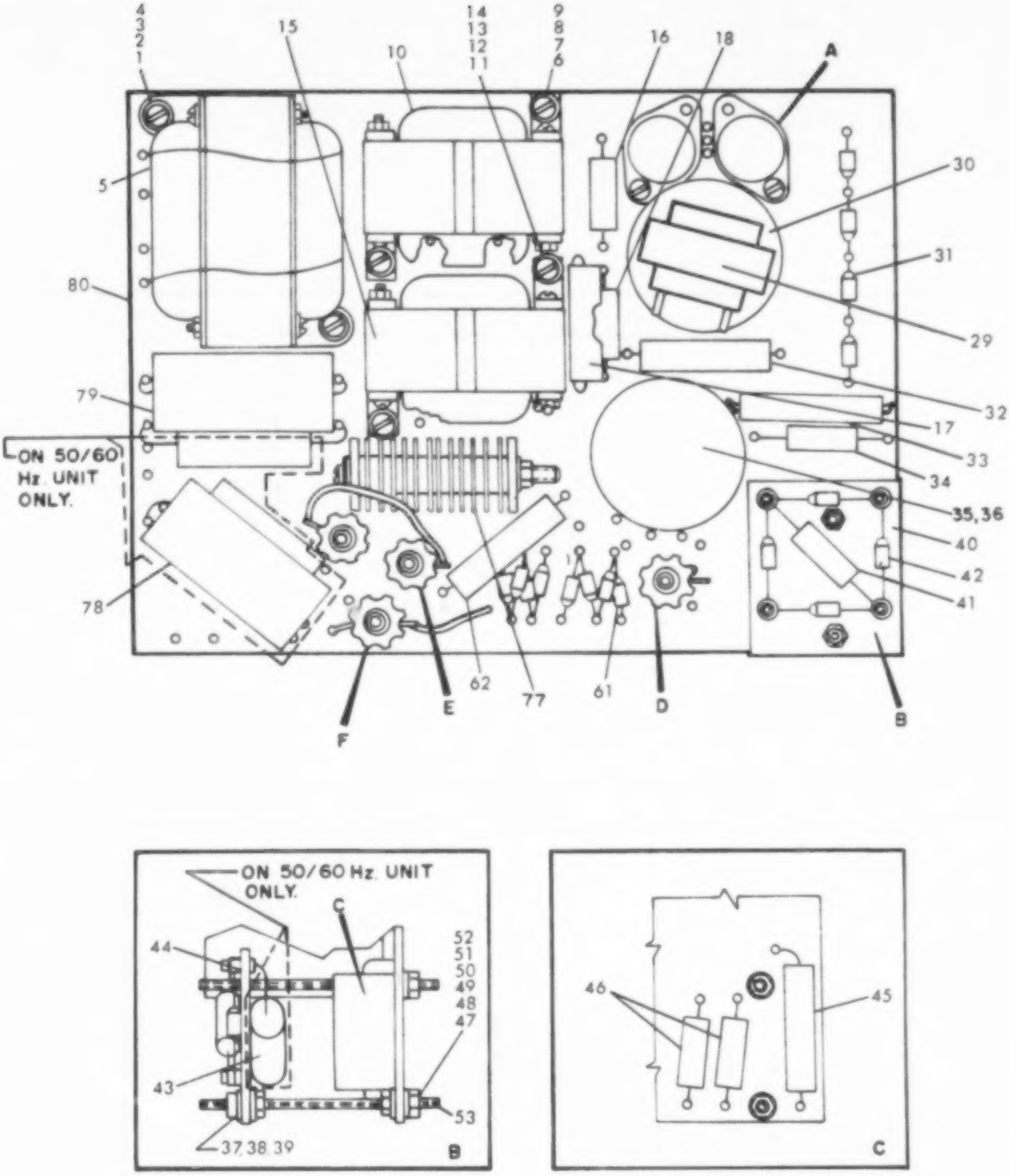
ME 6115-545-34/7-10

Figure 7-10. Electric Governor Control Unit, Parallel Winding Test (400 Hz)


GOVERNOR CONTROL UNIT
PC BOARD
L2
L1
T1
.020" FISH PAPER
.016" SHEET METAL

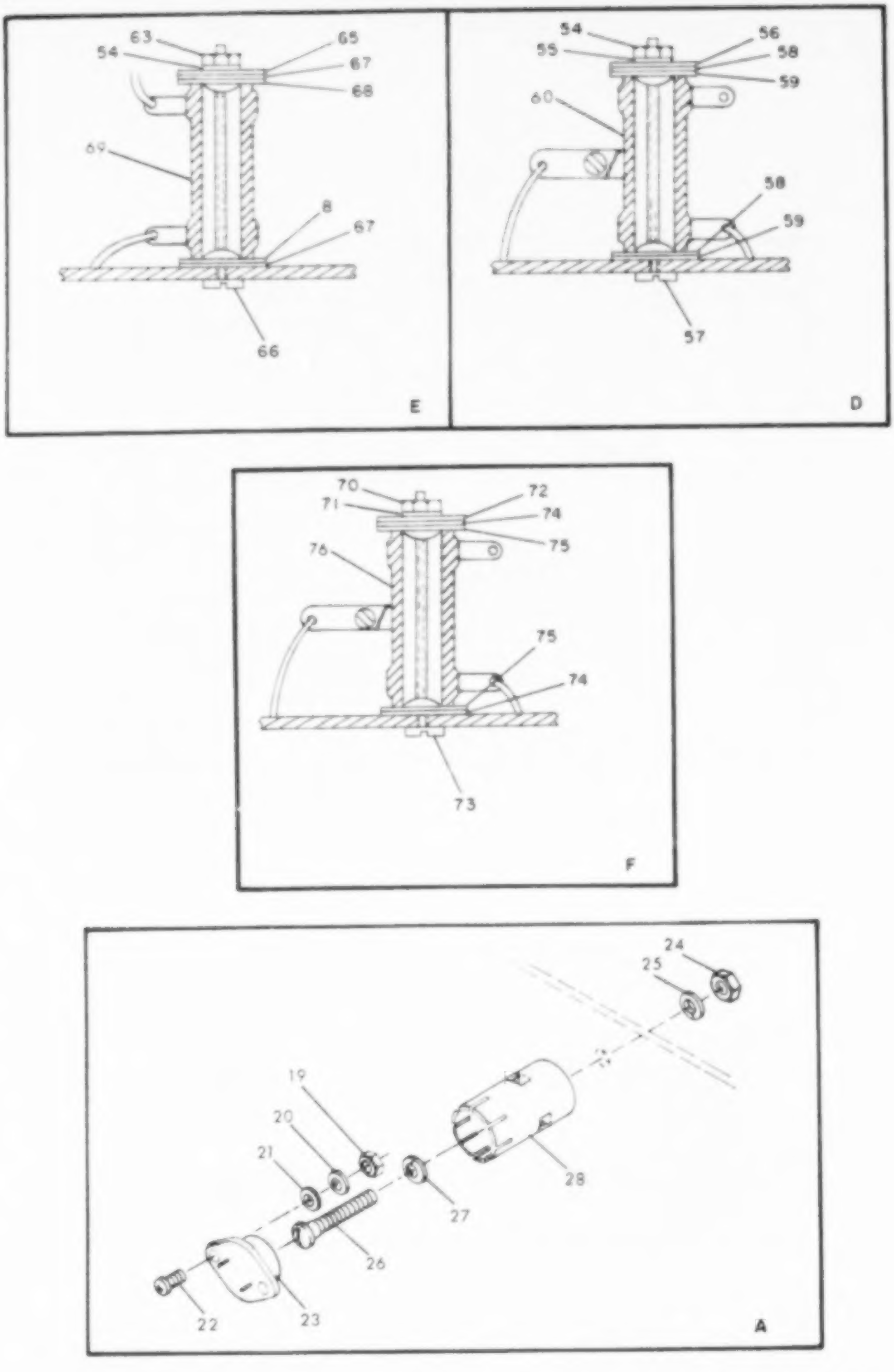
ME 6115-545-34/7-11

Figure 7-11. Electric Governor Control Unit, Test Position for Unpotted Units


4
3
2
1
15
10
14
13
12
11
9
8
7
6
16
18
A
30
31
29
32
17
33
34
35,36
40
42
41
5
80
79
ON 50/60 Hz. UNIT ONLY.
78
F
E
62
77
61
D
B
ON 50/60 Hz. UNIT ONLY.
C
44
52
51
50
49
48
47
43
53
37,38,39
B
46
45
C

ME 6115-545-34/7-12 (1)

Figure 7-12. Electric Governor Wiring Board Assembly (Sheet 1 of 2)


63
54
65
67
68
69
8
67
66
E
54
55
56
58
59
60
58
59
57
D
70
71
72
74
75
76
75
74
73
F
24
25
19
20
21
28
27
26
22
23
A

ME 6115-545-34/7-12(2) C1

Figure 7-12. Electric Governor Wiring Board Assembly (Sheet 2 of 2)

KEY to fig. 7-12

1. Nut (2)
2. Lock washer (2)
3. Flat washer (2)
4. Screw
5. Transformer (T1)
6. Nut (2)
7. Washer (2)
8. Washer (2)
9. Screw
10. Reactor (L1)
11. Nut (2)
12. Washer (2)
13. Washer (2)
14. Screw (2)
15. Reactor (22) (L2)
16. Resistor (R5)
17. Capacitor (C7)
18. Resistor (R23)
19. Nut (2)
20. Washer (2)
21. Washer (2)
22. Screws (2)
23. Transistor (Q1 & Q2)
24. Nut (2)
25. Washer (2)
26. Screw (2)
27. Washer (2)
28. Heat sink (2)
29. Reactor (L3)
30. Transformer (T2)
31. Rectifiers (CR3, CR4, CR5, CR6)
32. Capacitor (C9)
33. Resistor (R20)
34. Resistor (R22)
35. Nut (1)
36. Mag amp (AR1)
37. Nut (2)
38. Washer (2)
39. Washer (2)
40. Board assy
41. Resistor (R37)
42. Rectifiers (CR7, CR8, CR9, CR10)
43. Capacitor(C2)
44. Board
45. Capacitor (C5)
46. Resistor (R4, R8)
47. Nut (2)
48. Washer (2)
49. Washer (2)
50. Washer (2)
51. Washer (2)
52. Nut (2)
53. Studs (2)
54. Nut (1)
55. Washer (1)
56. Flat washer (1)
57. Screw (1)
58. Washer (2)
59. Washer (2)
60. Resistor (R10)
61. Rectifiers (8)
62. Capacitor (C6)
63. Nut (2)
64. Washer (2)
65. Washer (2)
66. Screw (2)
67. Washer (4)
68. Washer (4)
69. Resistor (1 & R1 A)
70. Nut (1)
71. Washer (1)
72. Washer (1)
73. Screw (1)
74. Washer (2)
75. Washer (2)
76. Resistor (R2)
77. Rectifier (CR2)
78. Capacitor (C4)
79. Capacitor (C3)
80. Board

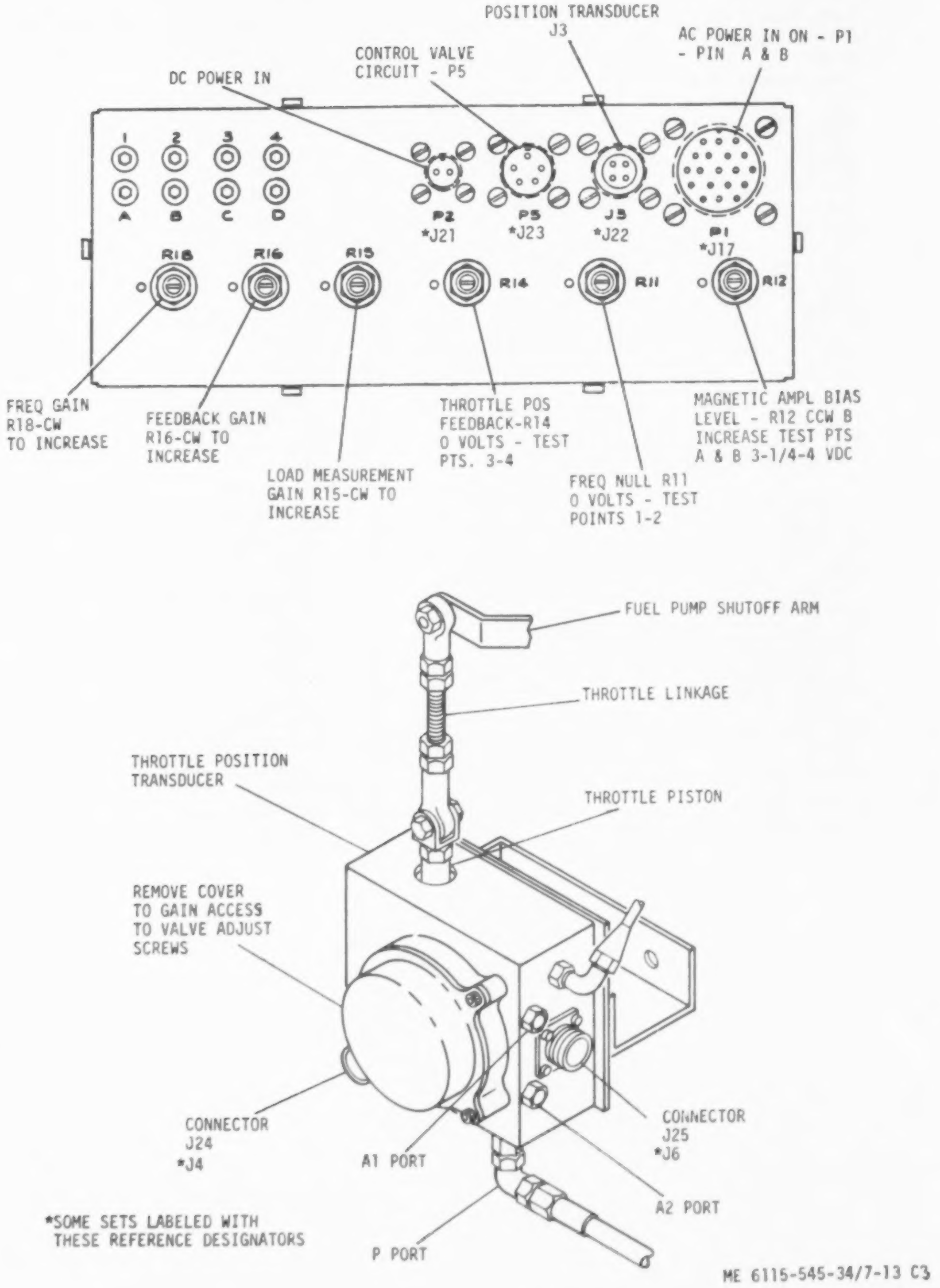

POSITION TRANSDUCER
J3
AC POWER IN ON - P1
- PIN A & B
CONTROL VALVE
CIRCUIT - P5
DC POWER IN
1
2
3
4
A
B
C
D
P2
*J21
P5
*J23
J3
*J22
P1
*J17
R18
R16
R15
R14
R11
R12
FREQ GAIN
R18-CW
TO INCREASE
FEEDBACK GAIN
R16-CW TO
INCREASE
LOAD MEASUREMENT
GAIN R15-CW TO
INCREASE
THROTTLE POS
FEEDBACK-R14
0 VOLTS - TEST
PTS. 3-4
FREQ NULL R11
0 VOLTS - TEST
POINTS 1-2
MAGNETIC AMPL BIAS
LEVEL - R12 CCW B
INCREASE TEST PTS
A & B 3-1/4-4 VDC
FUEL PUMP SHUTOFF ARM
THROTTLE LINKAGE
THROTTLE POSITION
TRANSDUCER
THROTTLE PISTON
REMOVE COVER
TO GAIN ACCESS
TO VALVE ADJUST
SCREWS
CONNECTOR
J24
*J4
A1 PORT
CONNECTOR
J25
*J6
A2 PORT
*SOME SETS LABELED WITH
THESE REFERENCE DESIGNATORS
P PORT
ME 6115-545-34/7-13 C3

Figure 7-13. Electric Governor Control Unit, Location of Adjustments and Controls

## 7-10 GOVERNOR CONTROL UNIT (MEP-115A).

a. General.

(1) The electric governing system is a speed (frequency) sensing system used to maintain constant engine speed and generator output frequency during periods of unchanging load and when load additions or deletions occur. The system consists of a control unit, magnetic pickup and an electric throttle actuating unit. The engine speed signal is obtained from a magnetic pickup mounted in the flywheel housing in close proximity to the flywheel ring gear. The frequency of the pickup signal is proportional to engine speed. Figure 7-14 shows the functional theory of operation.

(2) The control unit has four distinct circuits; pickup signal amplifier, frequency reference oscillator, phase comparator and output circuit.

(a) The Frequency Reference Oscillator is voltage controlled. The frequency setting is adjusted by applying zero to 10 volts at the Frequency Reference Oscillator input. The internal frequency adjust provides this voltage setting when the control unit is in operation. The Reference Oscillator does not maintain a constant frequency. It deviates from its nominal frequency as the engine speed changes during load changes. The Reference Oscillator is forced by the Phase Comparator to track the amplified pickup signal representing engine speed. The voltage representing speed error is the amount of voltage required to drive the Reference Oscillator off frequency in proportion to the engine speed deviation.

(b) The Phase Comparator Circuit receives signals from the Pickup Signal Amplifier and the Reference Frequency Oscillator and compares the difference in frequency. The Phase Comparator measures the amount the engine signal is ahead or behind the Reference Oscillator signal. Its voltage output is used to force the Reference Oscillator to the same frequency as the signal from the engine. The Phase Comparator output is proportional to the speed error. The gain control is used to couple the Phase Comparator output to the Reference Oscillator. By increasing the coupling, a small voltage change from the Phase Comparator represents a large frequency change and vice-versa.

(c) The Output Circuit allows governing by introducing a temporary drop during a load change for stability purposes. It has an adjustable means to control the magnitude and time constant of the drop to match the dynamic characteristics of the engine. The output current switching portion of the circuit provides current to drive the actuator. The output transistor is switched on and off at a frequency of 200 Hz. This is above the natural frequency of the actuator. The actuator responds to the average current from the transistor and moves in proportion to position the engine throttle. The output transistor is switched on and off to reduce power dissipation.

b. Malfunction.

The following procedures are to be performed with the Governor Control Unit in the generator set.

(1) Connect the breakout cable between wiring harness plug P17 (1, figure 7-15) and the electric governor.

(2) Using a digital voltmeter, make the voltage readings in table 7-4 at the breakout cable plug. All readings are measured between the terminal and ground. Terminals F, G, H and T are ground.

c. Removal.

(1) Disconnect electrical connector P17 (1, figure 7-15).

(2) Remove 4 hex head screws (2), lock washers (3) and nuts (4).

(3) Remove the control unit.

d. Installation.

Install the Governor Control Unit in reverse order of removal procedures.

e. Adjustment Procedure.

(1) Disconnect the actuator linkage rod from the engine fuel shutoff lever.

(2) Place the generator set START-RUN-STOP switch (located on the generator set control panel) in the RUN position.

(3) Place the generator set BATTLE SHORT SWITCH (located on the generator set control panel) in the ON (override) position.

(4) Beginning at the fully counterclockwise position, rotate the engine fuel shutoff lever in a clockwise direction until a slight resistance is felt; hold the lever in this position.

NOTE

This resistance is the fuel injection pump's internal governor linkage hook engaging the metering valve arm.

(5) Move the actuator lever to the "full fuel" position. This is the direction against the spring resistance (fully counterclockwise).

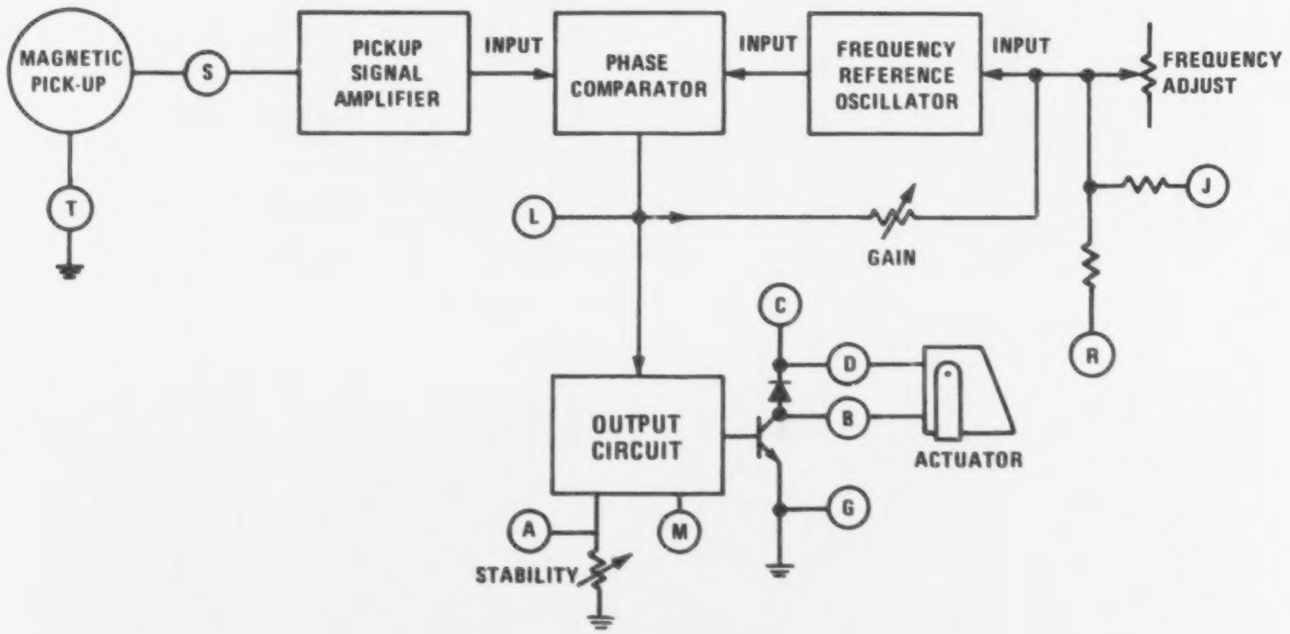

MAGNETIC PICK-UP
S
T
PICKUP SIGNAL AMPLIFIER
INPUT
PHASE COMPARATOR
INPUT
FREQUENCY REFERENCE OSCILLATOR
INPUT
FREQUENCY ADJUST
J
L
GAIN
R
C
D
B
OUTPUT CIRCUIT
ACTUATOR
G
A
M
STABILITY

Figure 7-14. Functional Theory of Operation

Table 7-4. Governor Malfunction Testing

| TERMINAL | NORMAL VALUE | PROBABLE CAUSE OF NON-NORMAL READING | CORRECTIVE ACTION |
|---|---|---|---|
| S | 1.0 volt AC-RMS minimum while cranking. | 1. Defective magnetic pickup.<br>2. Gap too large between magnetic pickup and gear teeth.<br>3. Improper or defective wiring to the magnetic pickup. | 1. Replace magnetic pickup.<br>2. Readjust magnetic pickup.<br>3. Replace wiring harness. |
| K | 10.1 ± .20 volts DC while energized (Internal regulated D.C. supply). | 1. D.C. power not connected or low battery voltage.<br>2. Frequency trim potentiometer shorted, grounded or miswired.<br>3. Wiring error.<br>4. Defective control unit. | 1. Connect D.C. power supply; replace D.C. battery.<br>2. Replace Control Unit.<br>3. Replace wiring harness.<br>4. Replace control unit. |
| L | Above 5.1 volts D.C. while running. (inverse speed error signal).<br>Above 5.1 volts is under speed signal. Below 5.1 volts is over speed signal.<br>On speed will indicate a steady 5.1 volts. | 1. Frequency adjust set too low.<br>2. Defective control unit. | 1. Turn Frequency adjust screw clockwise.<br>2. Replace control unit. |
| N | 8.5 to 9.5 volts D.C. while cranking. (Proportional actuator voltage). | 1. Battery voltage may be too low while cranking.<br>2. Defective Control Unit. | 1. Charge D.C. battery; replace D.C. battery.<br>2. Replace Control Unit. |
| B | 2.5 volts D.C. maximum while cranking. (Transistor voltage). | 1. Output transistor open (defective Control Unit).<br>2. Defective Actuator.<br>3. Error in wiring to Actuator. | 1. Replace Control Unit.<br>2. Replace Actuator.<br>3. Replace Wiring Harness. |

(6) Measure the center to center distance between the hole in the fuel shutoff lever and the hole in the actuator lever. Adjust the rod ends on the threaded linkage rod so that the center to center distance of the rod ends is the same or slightly longer than that measured between the fuel shutoff lever and the actuator lever. (The 3.75 dimension is only approximate. If the linkage is too short, the actuator lever will attain its "no fuel" position [full clockwise] before the fuel shutoff lever reaches its "no fuel" position; the fuel shutoff lever will never reach "no fuel". If the linkage is too long, the actuator lever will reach its "full fuel" position [full counterclockwise] before the fuel shutoff lever reaches its "full fuel" position; full load will not be reached.) It may be necessary to readjust the position of the fuel shutoff lever and/or the actuator lever to accommodate the center to center distance of the rod ends and to assure complete fuel shutoff and full load operation. Fuel shutoff and actuator lever adjustments will be covered under replacement procedures. Tighten the nuts on the linkage rod against the rod ends to maintain proper spacing.

(7) Return the generator set START-RUN-STOP switch to the STOP position and the BATTLE SHORT switch to the OFF position.

(8) Reconnect the actuator linkage rod end to the engine fuel shutoff lever.

(9) Adjust the control unit gain control to its approximate mid-range position.

(10) Adjust the control unit stability control to its fully counterclockwise position.

(11) Adjust the generator set frequency adjust potentiometer (pot) (located on the generator set control panel) to mid-range.

(12) Using a small screwdriver, turn the control unit frequency adjust screw (located on the left side vertical face of the control unit) at least 22 turns counterclockwise (opposite increase arrow). This will give the lowest possible engine governed speed.

NOTE

Two people will be required to adjust the control unit. Ensure that the actuator linkage rod and all levers are securely fastened and move freely (without binding) before operating the engine. Manually overcome the actuator until adjustment of the control unit is completed and the governor is in control. Adjustment of the control unit will be made with the engine operating in a no-load condition.

(13) Start the engine, manually operating the fuel shutoff lever.

(14) Turn the control unit frequency adjust screw clockwise until the proper engine speed is obtained. Several turns may be required. The generator set frequency adjust pot should now have sufficient adjustment travel to cause the generator set frequency meter to indicate beyond both of its extreme limits (388-412 Hz).

(15) If the engine is unstable as indicated by continuous movement of the actuator lever, turn the control unit gain control counterclockwise until stability is obtained as indicated by a stationary actuator lever. Readjust the control unit frequency adjust screw to the proper engine speed.

(16) Turn the control unit gain control clockwise until the engine becomes just unstable; back the gain control counterclockwise until the engine is again stable.

(17) Turn the control unit stability control clockwise until the engine becomes just unstable; back the stability control counterclockwise until the engine is again stable.

NOTE

The governor is now set to a nominally good operating point.

(18) Adjust control unit gain, stability and frequency under various load conditions and load changes to obtain the desired governing characteristics.

(19) When the electric governor system is properly adjusted, the locknuts on the control unit gain and stability controls should be tightened.

## 7-11. ACTUATOR UNIT.

a. Removal.

(1) Disconnect electrical connector P22, (1, figure 7-16).

(2) Disconnect the actuator lever from the actuator linkage rod by removing the hex head cap screw (2), flatwasher (3), and the self-locking nut (4).

NOTE

It may be necessary to remove the actuator bracket to gain access to the hardware securing the actuator to the actuator bracket. If this is not necessary, proceed to paragraph (3). If removal is required, then proceed as follows:

(a) Loosen the drive belt of the engine alternator.

(b) Remove the two hex head screws (5) and lock washers (6) securing the actuator bracket, through spacers (7), to the engine through the alternator mountng bracket.

(3) Disconnect the actuator from the actuator bracket by removing two hex head screws (8), flatwashers (9), lock washers (10) and nuts (11). Remove the actuator.

b. Testing.

(1) Using an ohmmeter, check for continuity between pins A and B and pins C and D. Replace actuator if there is no continuity.

(2) Check for short circuit between each pin on the connector and the housing. Replace actuator if any pin is shorted to case.

c. Installation.

(1) Position the actuator lever (12, figure 7-16) roughly horizontal by loosening the nut on the splined shaft end of the actuator lever, rotating the lever and tightening the nut.

(2) Align the actuator with the two holes in the actuator bracket, secure the actuator to the actuator bracket with two 3/4-inch long hex head screws (8), flatwashers (9), lock washers (10) and nuts (11).

NOTE

If the actuator bracket has not been removed, proceed with paragraph (3). If the bracket must be installed, proceed as follows:

(a) Insert the spacers (7) through the alternator mounting bracket.

(b) Secure the actuator bracket to the engine by inserting the two 1 1/2-inch long hex head screws (5), lockwashers (6), into the appropriate holes in the actuator bracket, through the spacers (7) and into the threaded holes in the engine; tighten the two screws.

(c) Adjust the drive belt of the engine alternator to the required tension and secure the alternator.

(3) Attach the actuator lever to the actuator linkage rod with the 1 1/4-inch long hex head cap screw (2), two flatwashers (3) and the self-locking nut (4).

(4) Connect electrical connector P22 (1).

## 7-12. ELECTRIC GOVERNOR MAGNETIC PICKUP.

a. Removal.

(1) Disconnect electrical connector P23 (1, figure 7-17).

(2) Loosen locknut (2) and unscrew the threaded magnetic pickup from the flywheel housing (3). Remove the magnetic pickup.

b. Testing.

(1) Using an ohmmeter, test for continuity between pins A and B on the connector.

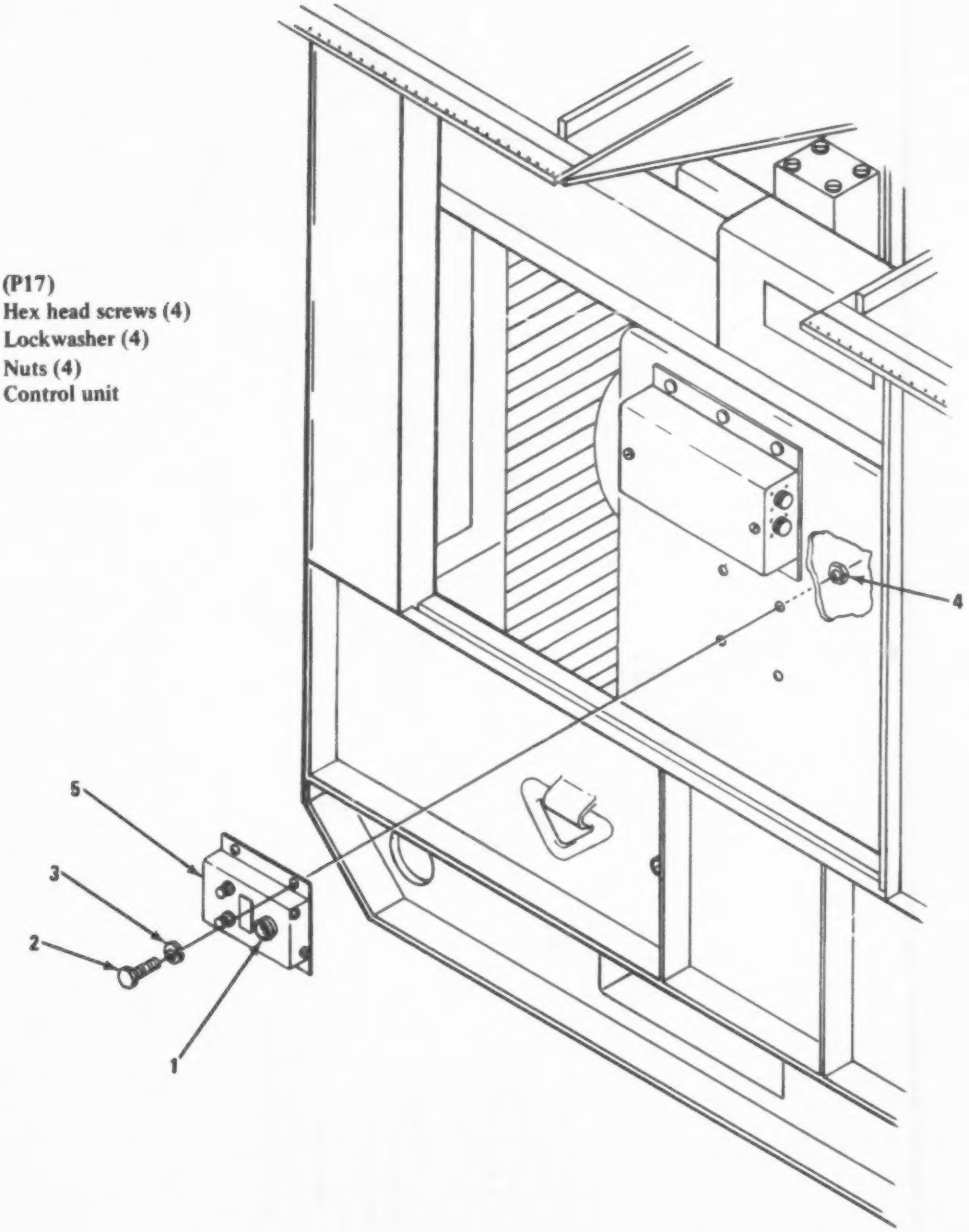
(2) If the circuit is open discard the magnetic pickup.

c. Installation

(1) Rotate the engine until the top land of one gear tooth is in line with the center of the threaded hole in the flywheel housing.

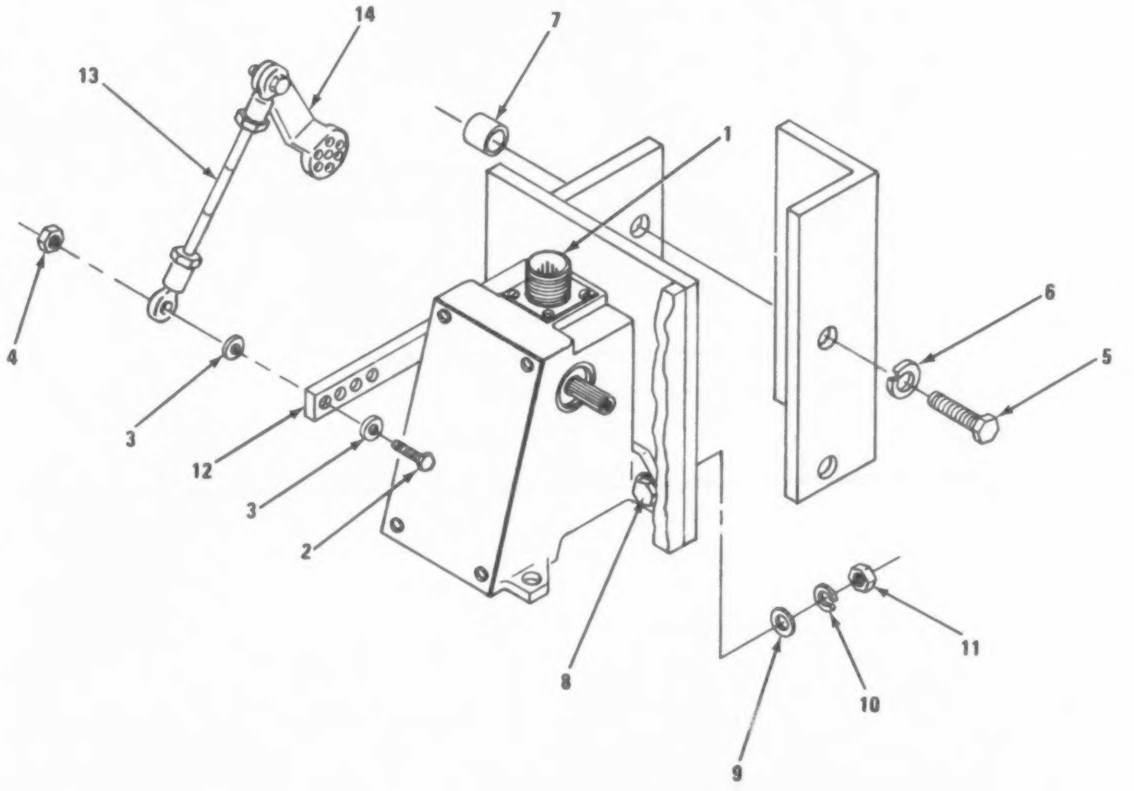
(2) Replace the magnetic pickup (3) into the threaded hole in the flywheel housing until the tip contacts the top of the gear tooth. Back the magnetic pickup out one-half to three-quarter turn and secure with the locknut (5) provided.

(3) Connect electrical connector P23 (1).



1. (P17)
2. Hex head screws (4)
3. Lockwasher (4)
4. Nuts (4)
5. Control unit

Figure 7-15. Governor Control Unit Removal and Installation



1. (P22)
2. Connector cap screw
3. Flat washer
4. Self-locking nut
5. 1¾" Lg hex head
6. Lock washer
7. Spacer
8. ¾" Lg hex head
9. Flat washer
10. Lock washer
11. Nut
12. Actuator lever
13. Actuator linkage rod
14. Engine fuel shutoff lever

Figure 7-16. Actuator Removal and Installation

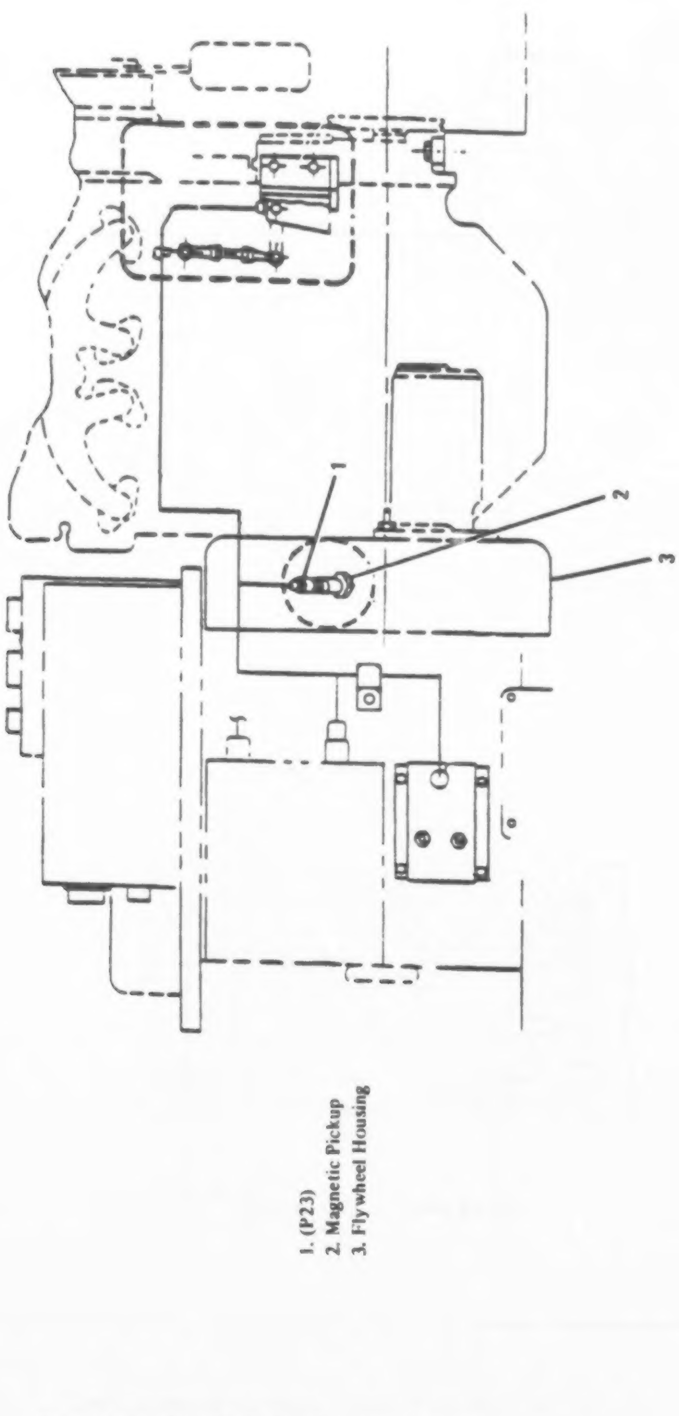

1
2
3
1. (P23)
2. Magnetic Pickup
3. Flywheel Housing

Figure 7-17. Magnetic Puckup Removal and Installation

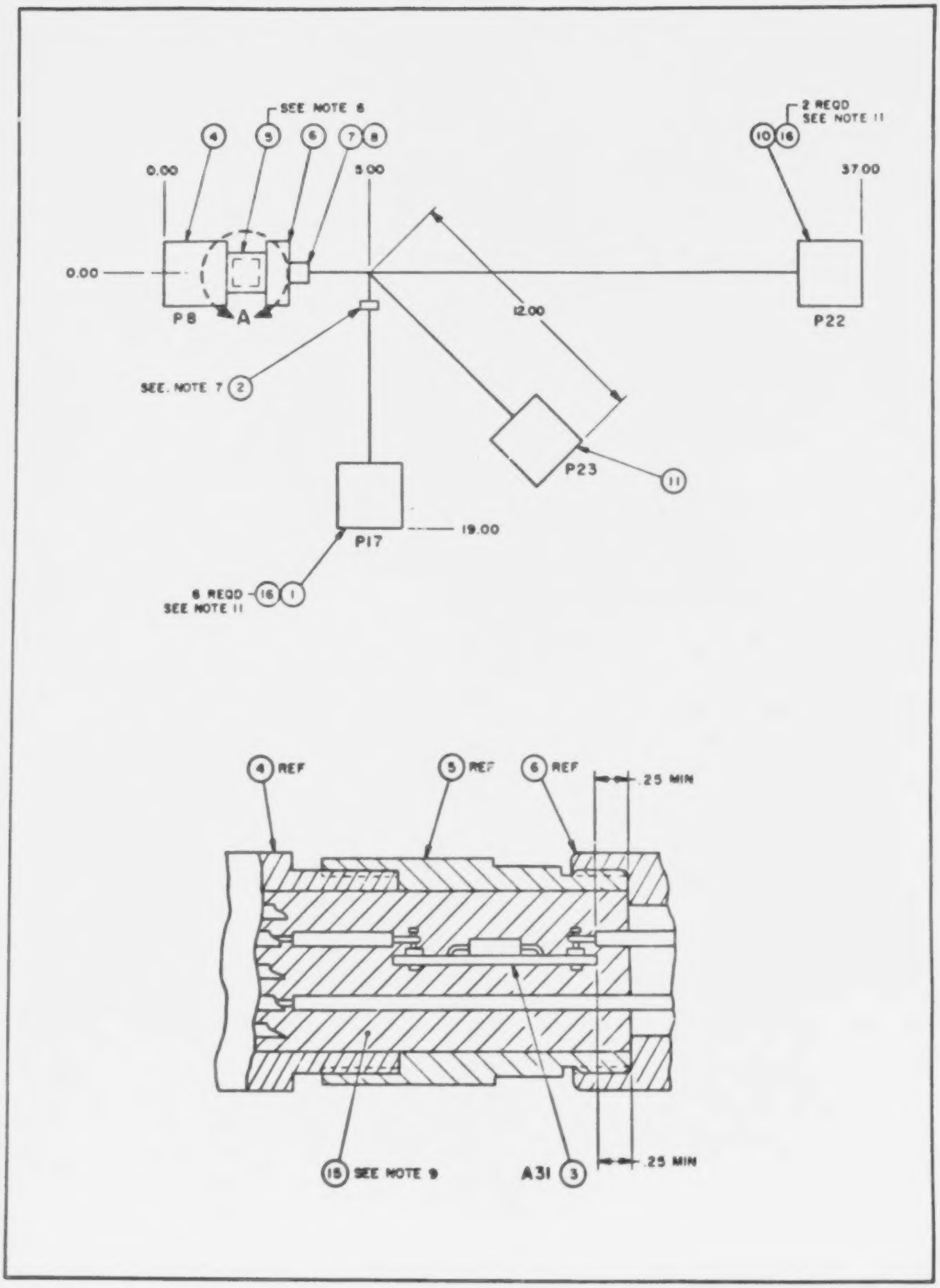

SEE NOTE 8
④
⑤
⑥
⑦⑧
2 REQD
SEE NOTE 11
⑩⑯
0.00
5.00
37.00
0.00
P8
A
P22
12.00
SEE. NOTE 7 ②
P23
⑪
P17
19.00
8 REQD ⑯①
SEE NOTE 11
④ REF
⑤ REF
⑥ REF
.25 MIN
⑮ SEE NOTE 9
A31 ③
.25 MIN

Figure 7-18. 400 Hz Electric Governor System Wiring Harness Assembly Drawing No. 84-704 (Sheet 1 of 2)

# CHAPTER 8

# RELAY TABLE GROUP REPAIR INSTRUCTIONS

## Section I. INTRODUCTION

### 8-1. Scope.

a. Section I of this chapter includes a brief description of the assemblies that make up the relay table group, overall functional operation, symptoms of relay table group malfunction, and relay table group equipment tests.

b. Subsequent sections of this chapter include repair instructions for the assemblies which are part of the relay table group.

### 8-2. Relay Table Group Description.

a. The relay table and related parts (fig. 8-1) includes the control relay assemblies, the excitation assembly exciter and the load measuring unit. The load measuring unit, and the excitation assembly exciter are common to all modes and classes of sets. Control relay assemblies include the tactical relay assembly (used on all sets), precise relay assembly (used on Mode I, Class 1 sets), and two different special relay box assemblies (one used on Mode I sets and the other used on Mode II sets).

b. The tactical, precise, and special relay box assemblies contain control relay modules for overvoltage, short circuit, and reverse power on all sets. Class 1 sets also contain additional control relay modules for underfrequency, undervoltage, and permissive paralleling.

c. The excitation assembly exciter system provides control of excitation voltage to the main generator to produce voltage buildup in the generator field coils. The excitation system assembly contains a voltage regulator that senses the generator output voltage and uses it as a reference to control field current in the generator and thus regulate the generator output voltage level.

d. The load measuring unit (LMU) is supplied on all sets. The LMU provides a dc signal proportional to the real power (kw) being delivered by the main generator. Refer to paragraphs 7-1 and 7-2.

### 8-3. Relay Table Group Symptoms and Isolation of Malfunction.

Malfunctions in the relay table group will be electrical in nature, and will affect the generator output voltage, via the excitation system assembly, and normal system operation due to a malfunctioning protection relay in the tactical precise or set special relay box assembly. If the set is in operable condition, the equipment tests listed in table 8-1 can be performed to isolate the malfunction.

## Section II. CONTROL RELAY ASSEMBLIES

### 8-4. Scope

This section includes repair instructions for the tactical relay assembly, precise relay assembly, and special relay box assemblies.

### 8-5. Removal.

See figure 8-1, unscrew electrical connectors, and remove the tactical relay assembly (2), precise relay assembly (4), special relay assembly (14), excitation assembly (18), and relay table (52), as required.

### 8-6. Disassembly.

NOTE

Tag all electrical connections removed during disassembly for position identification during reassembly.

a. Tactical Relay Box Assembly.

(1) See figure 8-2 and disassemble the tactical relay assembly as follows:

(a) Remove screws (1) and washers (1A) and remove cover (2).

(b) Tag and disconnect all wiring harness leads.

(c) Complete disassembly in accordance with figure 8-2.

(2) See figure 8-3 and disassemble the tactical relay resistor assembly.

b. Precise Relay Box Assembly (Class 1 Sets).

(1) On Class 1, Mode 1 Sets, see figure 8-4 to disassemble the precise relay box assembly.

NOTE

**Tag and disconnect all electrical leads prior to removal of wiring harness (7).**

(2) See figure 8-5 for disassembly of the resistor assembly.

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Table 8-1. Relay Table Group Equipment Tests

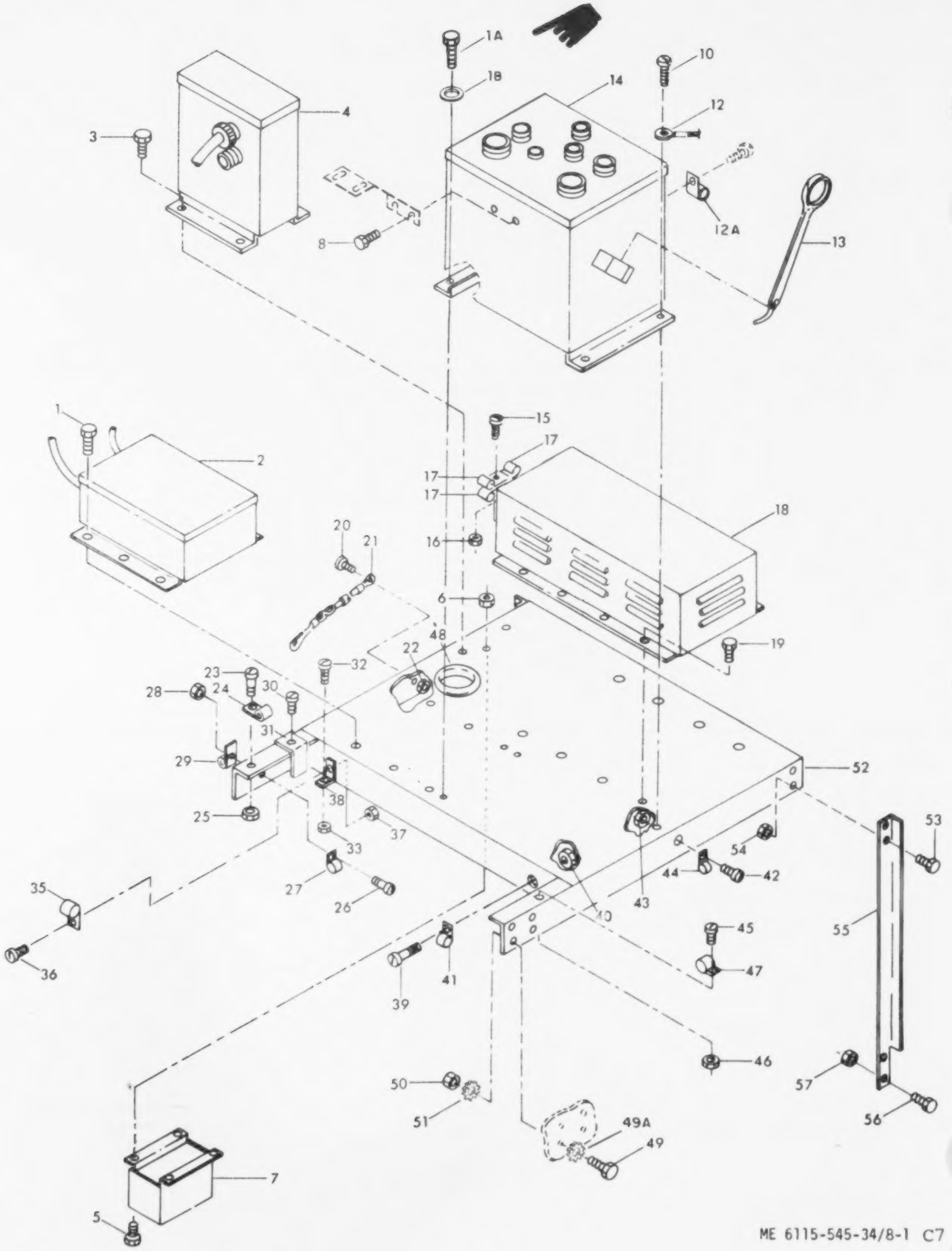
| Malfunction | On equipment test | | Malfunctioning assembly | Location |
|---|---|---|---|---|
| 1. Main generator output too low, too high, or failure to flash. | Separately excite field with dc power supply. | a. Output normal. | a. Excitation system assembly. | a. Relay table group. |
| | | b. Output low, high, or will not flash. | b. Generator assembly. | b. Generator assembly. |
| 2. Generator runs at less than 130 percent of rated current for 10 minutes; CB2 drops out and overload indicator lights. | Place battle short switch in on position. | a. Overload indicator lights and CB2 remains close. | a. Overload relay. | a. Tactical relay box. |
| | | b. Unit operates normally. | b. See table 2-2. | b. See table 2-2. |
| 3. Generator runs at normal voltage, set shuts down and overvoltage indicator lights. | Place battle short switch in on position; overvoltage indicator lights but the set does not shut down. | | Overvoltage relay. | Tactical relay box. |
| 4. Generator runs at rated voltage, CB2 drops out and undervoltage indicator lights. | Place battle short switch in on position; undervoltage indicator lights and CB2 remains close. | | Undervoltage relay. | Mode I - Precise relay box.<br>Mode II - Special relay box. |
| 5. Generator runs at rated load, CB2 drops out, and short circuit indicator lights. | None required. | | Short circuit relay. | Tactical relay box. |
| 6. Generator runs at rated load, CB2 drops out, and reverse power indicator lights. | Place battle short switch in on position; reverse power indicator lights and CB2 remains close. | | Reverse power relay. | Mode I - Precise relay box.<br>Mode II - Special relay box. |
| 7. Generator runs at rated load, CB2 drops out with no malfunction indicated. | Place battle short switch in on position; unit operates normally. | | Permissive parallel relay. | Mode I - Precise relay box.<br>Mode II - Special relay box. |
| 8. Generator runs at rated frequency, CB2 drops out, and underfrequency indicator lights. | Place battle short switch in on position; underfrequency indicator lights and CB2 remains close | | Underfrequency relay. | Mode I - Precise relay box.<br>Mode II - Special relay box. |

Table 8-1. Relay Table Group Equipment Tests (Cont)

| Malfunction | On equipment test | Malfunctioning assembly | Location |
|---|---|---|---|
| 9. Paralleling lamps do not illuminate when the single-parallel switch is placed to the parallel position when attempting to parallel two generators. | Check resistance between connections 19 and 20, 7 and 8 of A5, dc relay assembly. Resistance should be 7500 ± 5 percent ohms. An infinite resistance indicates a malfunction. | Dc relay assembly. | Special relay box. |
| 10. Engine generator set cranks, but will not start. | Check resistance between A5 connections 21 and 24 with the positive lead or connection 21. The value indicated will be approximately 500 ohms. Reverse the leads, the resistance shall be infinite. An infinite resistance in both directions indicates a malfunction. | Dc relay assembly. | Special relay box. |
| 11. Engine-generator set will not start. | Check resistance between A5 connections 11 and 10 with the positive lead on connection 11. The value indicated will be approximately 500 ohms. Reverse the leads, the resistance shall be infinite. An infinite resistance in both directions indicates a malfunction. | Dc relay assembly. | Special relay box. |

Key to Figure 8-1

1. Screw
1A. Screw
1B. Washer
2. Tactical relay box assy
3. Screw
4. Precise relay box assy
Mode I. Class 1 sets only
5. Screw
6. Nut
7. Load measuring unit
8. Screw
9. (Deleted)
10. Screw
11. (Deleted)
12. Terminal lug
12A. Clamp
13. Wrench
14. Special relay box assy
15. Screw
16. Nut
17. Clamp
18. Excitation assy
19. Clamp
20. Screw
21. Chain
22. Nut
23. Screw
24. Clamp
25. Nut
26. Screw
27. Clamp
28. Nut
29. Clamp
30. Screw
31. Bracket
32. Screw
33. Nut
34. (Deleted)
35. Clamp
36. Screw
37. Nut
38. Bracket
39. Screw
40. Nut
41. Clamp
42. Screw
43. Nut
44. Clamp
45. Screw
46. Nut
47. Clamp
48. Grommet
49. Screw
49A. Washer
50. Nut
51. Washer
52. Table
53. Screw
54. Nut
55. Support bracket
56. Screw
57. Nut


1A
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10
14
12
4
3
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8
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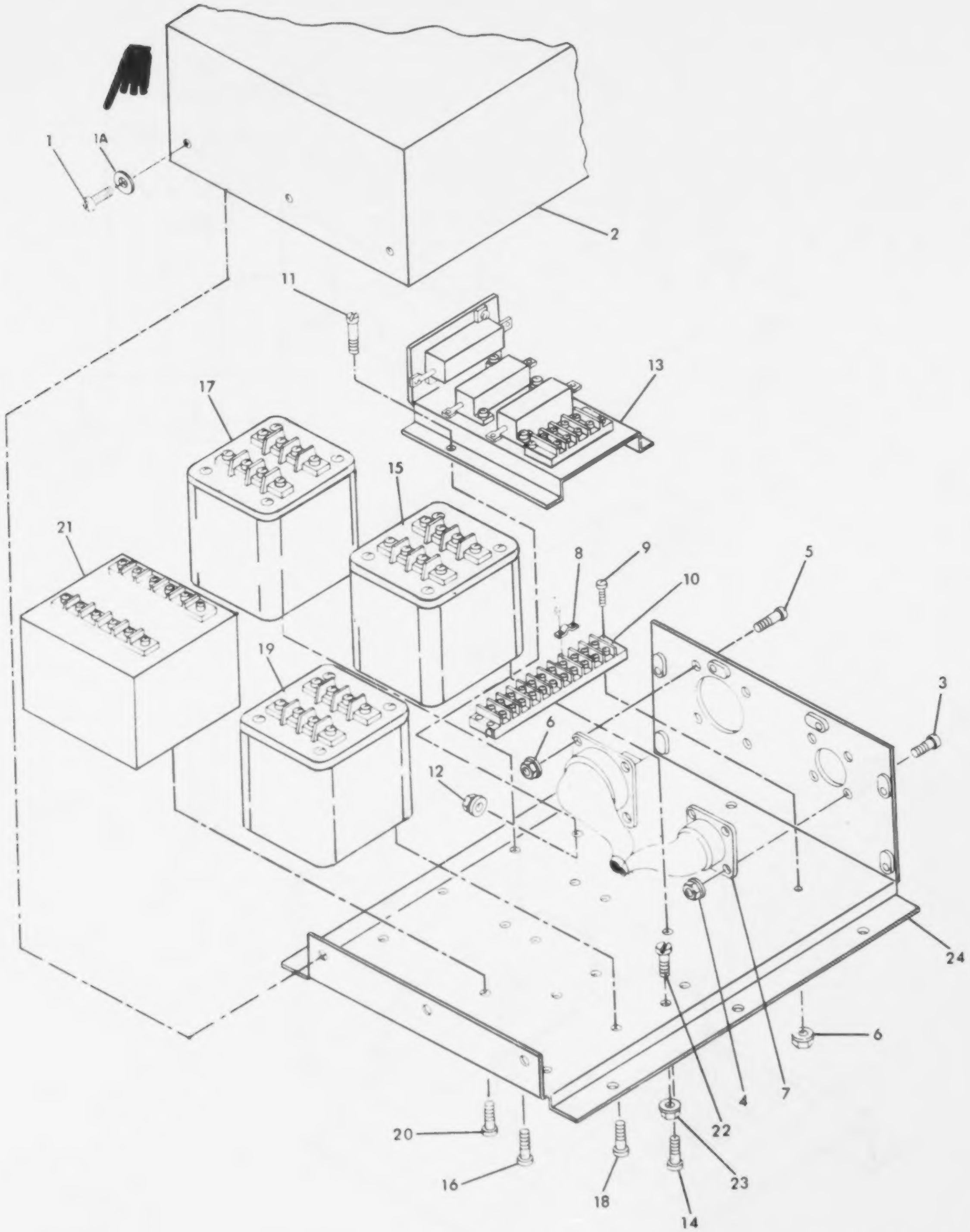
ME 6115-545-34/8-1 C7

Figure 8-1. Relay Table and Related Parts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9
10
5
19
3
6
12
24
6
4
7
22
20
16
18
23
14

1. Screw
1A. Washer
2. Cover
3. Screw
4. Nut
5. Screw
6. Nut
7. Wiring harness
8. Jumper
9. Screw
10. Terminal board
11. Screw
12. Nut
13. Resistor assy
14. Screw
15. Over voltage relay module
16. Screw
17. Short circuit relay module
18. Screw
19. Reverse power relay module
20. Screw
21. Overload relay module
22. Screw
23. Nut
24. Chassis

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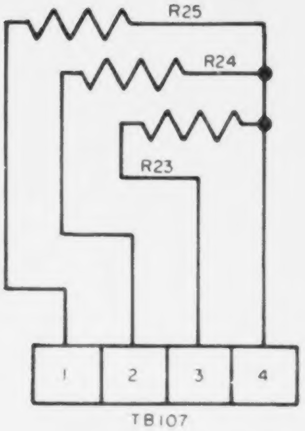
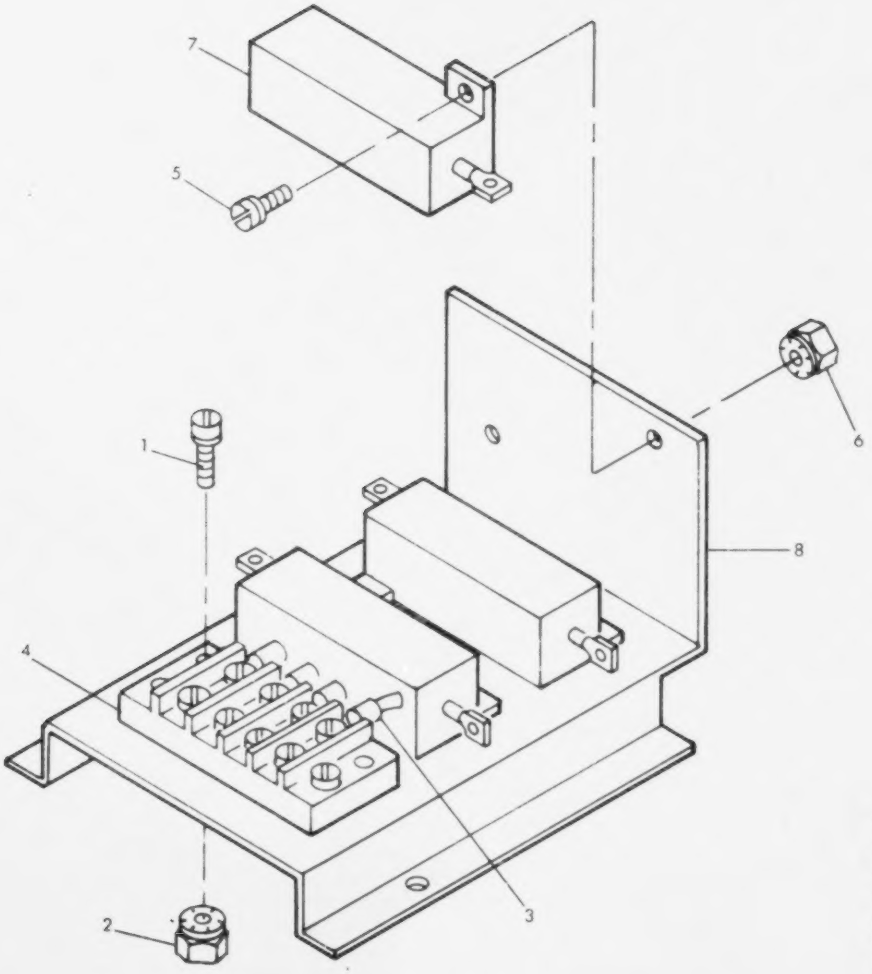
Figure 8-2. Tactical Relay Box Assembly

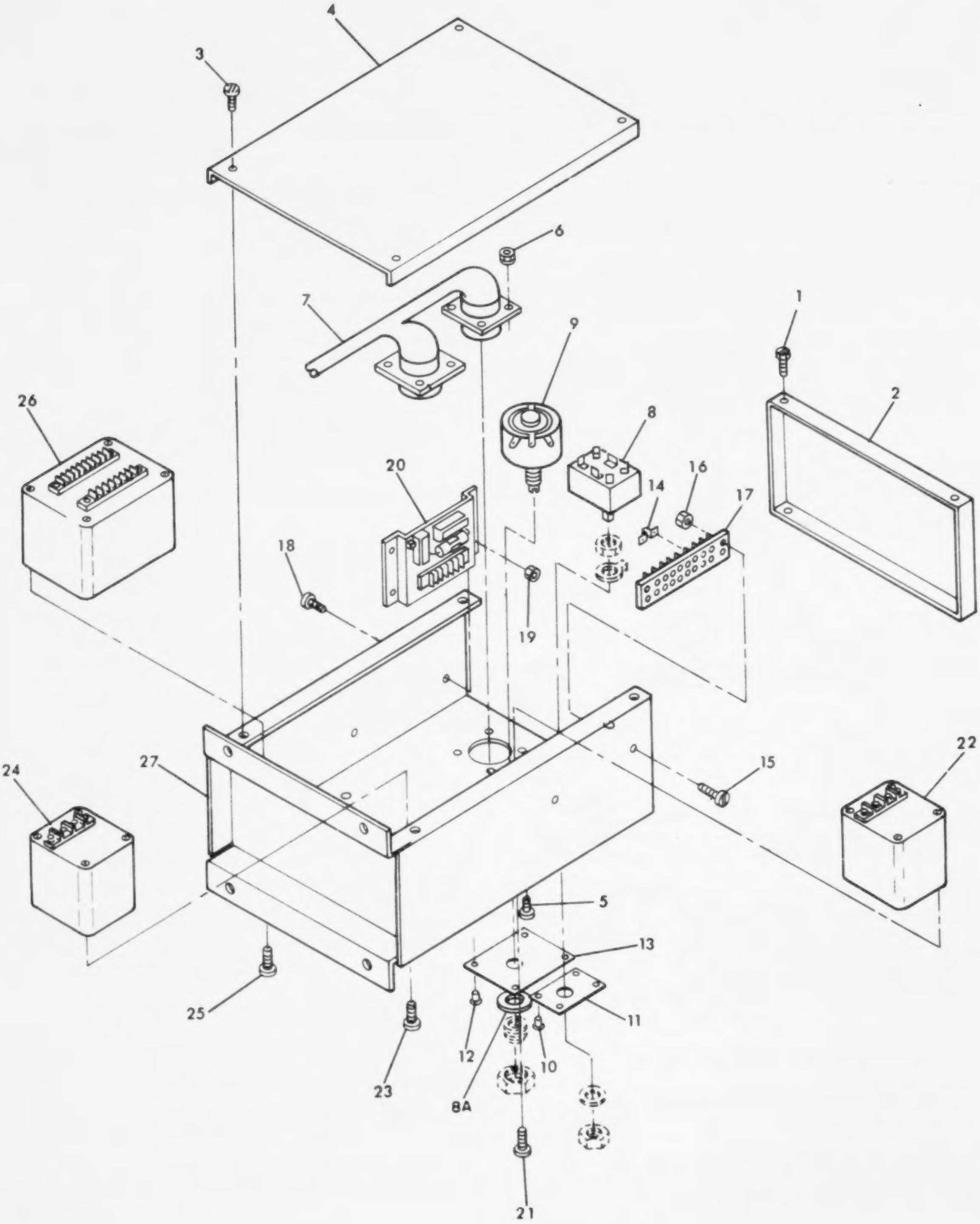

R25
R24
R23
1
2
3
4
TB107



1. Screw
2. Nut
3. Terminal
4. Terminal board
5. Screw
6. Nut
7. Resistor (3)
8. Bracket

ME 6115-545-34/8-3

Figure 8-3. Tactical Relay Resistor Assembly


4
3
6
7
9
1
26
2
8
20
16
14
17
18
19
27
24
15
22
5
13
25
11
12
10
23
8A
21

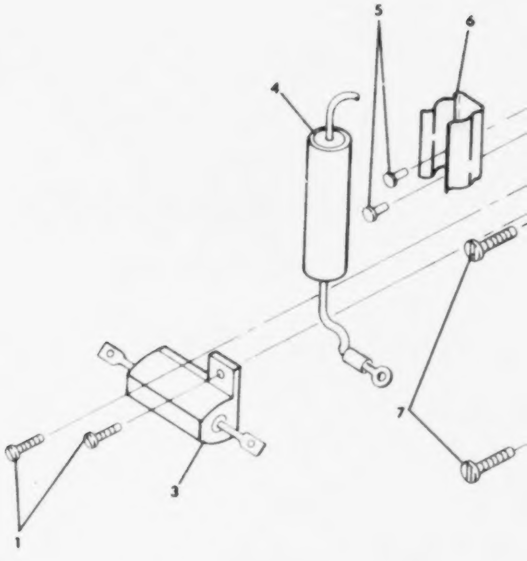
1. Screw
2. Cover
3. Screw
4. Cover
5. Screw
6. Nut
7. Wiring harness
8. Switch

**8A. Washer**

9. Rheostat
10. Rivet
11. Plate
12. Rivet
13. Plate
14. Jumper
15. Screw
16. Nut
17. Terminal board
18. Screw
19. Nut
20. Resistor assy
21. Screw
22. Under frequency relay module
23. Screw
24. Permissive parallel relay module
25. Screw
26. Under voltage relay module
27. Chassis

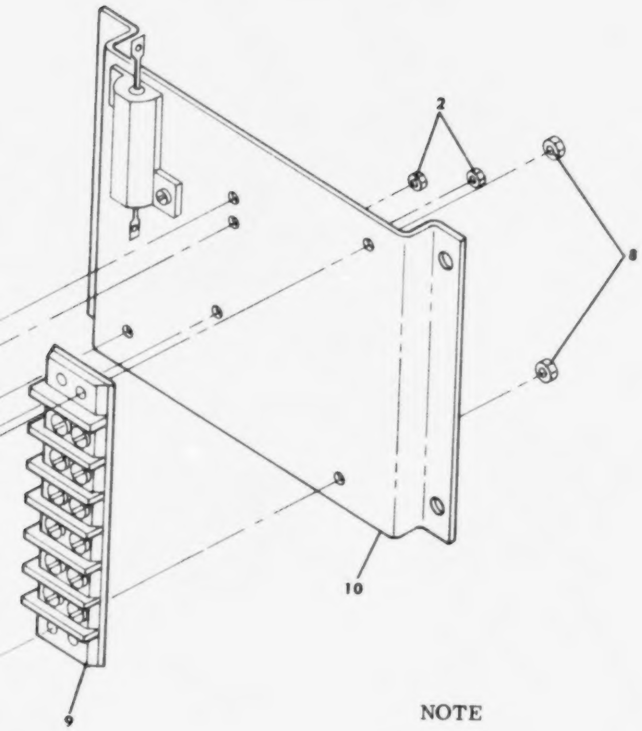
ME 6115-545-34/8-4 C1

Figure 8-4. Precise Relay Box Assembly



1. Screw
2. Nut
3. Resistor
4. Capacito
5. Eyelet

Figure 8-5. Re



NOTE

USE ONLY ON CLASS 1 SETS.

r

6. Clip
7. Screw
8. Nut
9. Terminal board
10. Bracket

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sistor Assembly (A6)

c. Special Relay Box Assembly.

(1) See figure 8-6 and disassemble the special relay box assembly as follows:

(a) Remove screws (1) which secure cover (44) to housing (79).

(b) Remove screws (1) which secure panel (2) to housing (79).

(c) Remove screws (11, 14, 16, 18, 20, 22, 24, 26, and 28) and nuts (12, 15, 17, 19, 21, 23, 25, 27, and 29) which secure wiring harness connectors to cover (44) and housing (79), and remove gaskets (31, 32, 33, 34, 35 and 37) and cover (44).

(d) Remove attaching hardware from all components within the special relay box and remove wiring harness (30) with components connected.

(e) Tag and disconnect wiring harness leads from components.

(2) See figure 8-5 to disassemble the resistor assembly of the special relay box assembly (Mode II Sets only).

(3) See figure 8-7 to disassemble the dc relay assembly of the special relay box assembly.

8-7. Inspection and Testing.

a. Tactical Relay Box Assembly.

(1) Inspect all components for signs of physical damage.

(2) Test the short circuit relay as follows:

(a) Connect a light and a 24 Vdc power supply in series with terminals 5 and 6 (DS1), also with terminals 7 and 8 (DS2). Relay trip will be indicated by the two lights. DS1 shall extinguish; DS2 shall light. See figure 8-8 for test setup.

(b) Connect a variable (0 to 120 volts) ac voltage source (50 to 400 Hz) between terminals 1 and 4 and slowly increase the voltage. The relay shall transfer lights when voltage equals 24 volts ± 1 volt. Repeat the test with the input connected to 2 and 4, and then again, between 3 and 4 by moving switch S2. The trip points should be within 1 volt of each other.

(c) Terminals 5, 6, 7, 8 and terminals 1, 2, 3, 4 shall be electrically isolated with the relay in either position.

(3) Test the overvoltage relay as follows.

(a) Connect a variable (0 to 160 volts) ac voltage source and variable frequency (50 to 450 Hz) source to terminals 1 and 2. (See fig. 8-9.)

(b) Connect a lamp and 24 Vdc power supply in series with terminals 3 and 4 (DS1), also with terminals 7 and 8 (DS2).

(c) Set voltage to 120 volts on terminals 1 and 2 and vary the frequency from 50 to 450 Hz. DS1 should stay lit and DS2 shall remain extinguished.

(d) Slowly increase the voltage to 149 volts. Vary the frequency from 350 to 450 Hz. DS1 should stay lit and DS2 shall remain extinguished.

(e) Slowly increase the voltage to 154 volts. Vary the frequency from 50 to 100 Hz. DS1 should stay lit and DS2 shall remain extinguished.

(f) Set the frequency at 50 Hz and increase the voltage to 156 volts. DS1 shall extinguish and DS2 shall light. Repeat for the frequency at 60, 70 and 100 Hz. After each trip, remove ac power to clear the relay.

(g) Set the frequency at 350 Hz and increase the voltage to 151 volts. DS1 shall extinguish and DS2 shall light. Repeat for the frequency 400 to 450 Hz. After each trip, remove ac power to clear the relay.

(h) Terminals 3, 4, 5, and 6, 7, 8 and terminals 1 and 2 shall be electrically isolated.

(4) Test the reverse power relay as follows:

(a) Connect relay as illustrated in figure 8-10.

(b) With all switches open, energize 5 Vdc variable power supply and adjust until V1 reads 3 volts.

(c) Position switch S2 to B. Energize 24 Vdc supply and close switches S4, S1, and S5. Lamp DS2 should light and DS1 should be extinguished.

(d) Energize 0 to 10 Vac power supply and adjust voltage until V2 indicates 5 volts. Adjust 0 to 5 Vdc supply to a value less than 1 Vdc shown on V1. Position switch S2 to A and close switch S3. Raise voltage of 0 to 5 Vdc power supply until DS2 extinguishes and DS1 lights. DS1 should light when V1 indicates 1 to 3 volts.

(5) Test the overload relay as follows:

(a) Connect the relay in the test setup shown in figure 8-11.

(b) With the 120/208 Vac power source energized, turn on the 24 Vdc power supply and close switch S1. Lamp DS1 should light and DS2 should be extinguished.

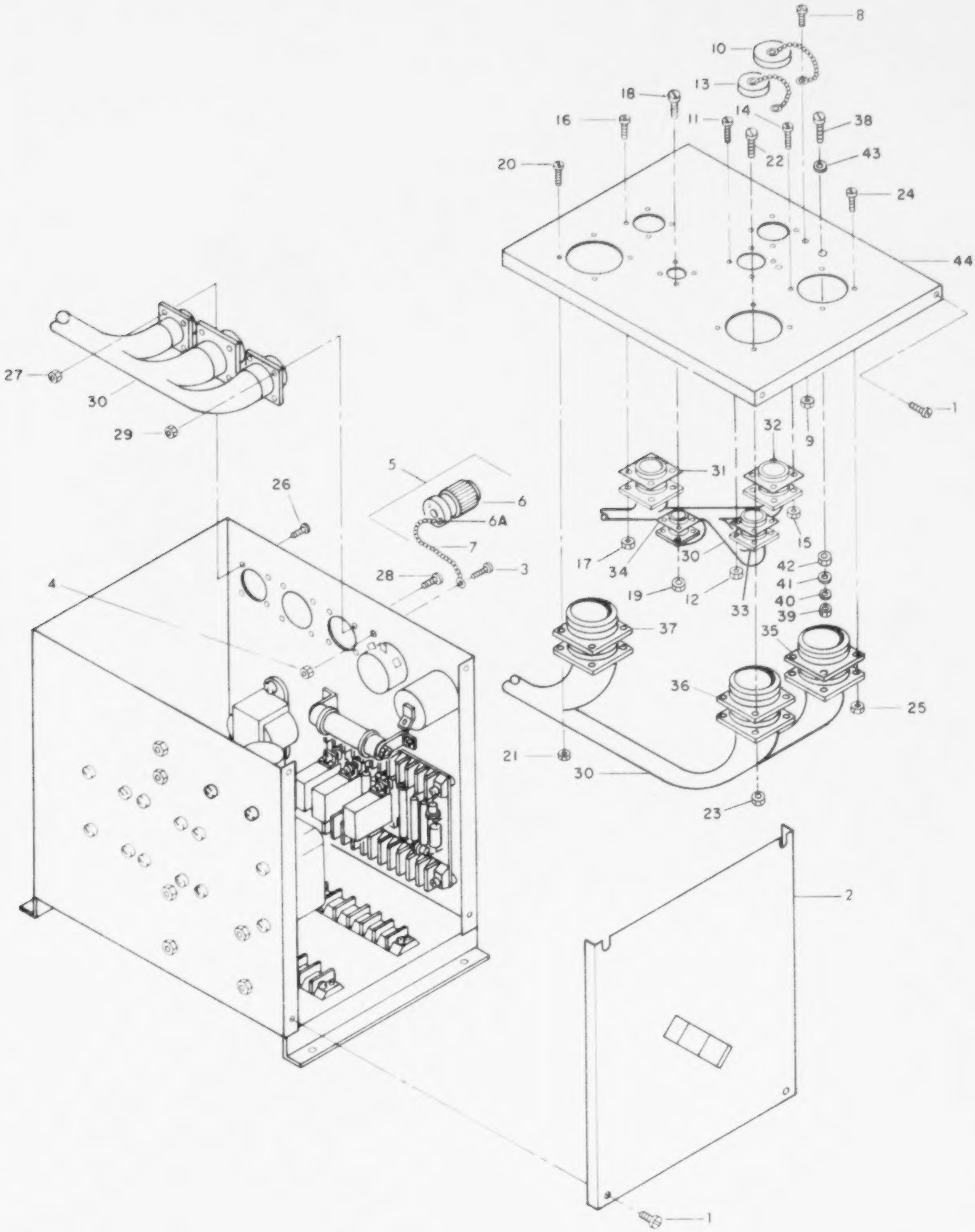
(c) Adjust autotransformers T1, T2 and T3 until ammeters A1, A2, and A3 indicate 0.75 ampere. DS1 and DS2 should not change states.

(d) Adjust autotransformer T1 until ammeter A1 indicates 0.975 ampere. After ± 2 minutes, DS1 and DS2 should transfer states.

Key to fig. 8-6.

| | |
|---|---|
| 1. | Screw |
| 2. | Panel |
| 3. | Screw |
| 4. | Nut |
| *5. | Connector assy |
| *6. | Connector |
| *6A. | Screw |
| *7. | Chain |
| 8. | Screw |
| 9. | Nut |
| 10. | Dust cap |
| 11. | Screw |
| 12. | Nut |
| 13. | Dust cap |
| 14. | Screw |
| 15. | Nut |
| 16. | Screw |
| 17. | Nut |
| 18. | Screw |
| 19. | Nut |
| 20. | Screw |
| 21. | Nut |
| 22. | Screw |
| 23. | Nut |
| 24. | Screw |
| 25. | Nut |
| 26. | Screw |
| 27. | Nut |
| 28. | Screw |
| 29. | Nut |
| 30. | Wiring harness |
| 31. | Gasket |
| 32. | Gasket |
| 33. | Gasket |
| 34. | Gasket |
| 35. | Gasket |
| 36. | Gasket |
| 37. | Gasket |
| 38. | Screw |
| 39. | Nut |
| 40. | Washer |
| 41. | Washer |
| 42. | Nut |
| 43. | Washer |
| 44. | Cover |
| **45. | Rheostat (R28) |
| **46. | Rivet |
| **47. | Plate |
| 48. | Rheostat (R29) |
| 49. | Rivet |
| 50. | Plate |
| 51. | Nut |
| 52. | Screw |
| 53. | Transformer |
| 54. | Screw |
| 55. | Nut |
| 56. | Resistor |
| 57. | Bracket |
| 58. | Nut |
| 59. | Dc relay assy |
| 60. | Jumper |
| 61. | Screw |
| 62. | Terminal board |
| 63. | Screw |
| 64. | Terminal board |
| 65. | Screw |
| 66. | Shunt |
| 67. | Nut |
| 68. | Screw |
| 69. | Relay |
| 70. | Nut |
| **71. | Relay Persmissive Parallel (K16) |
| 72. | Screw |
| **73. | Relay Underfrequency (K12) |
| 74. | Screw |
| **75. | Relay Undervoltage (K11) |
| 76. | Nut |
| 77. | Screw |
| **78. | Resistor assy (A6) |
| 79. | Housing |

* - Mode I sets
** - Mode II sets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6A
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35
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25
21
30
23
2
1

ME 6115-545-34/8-6(1) C1

Figure 8-6. Special Relay Box Assembly (Sheet 1 of 2)

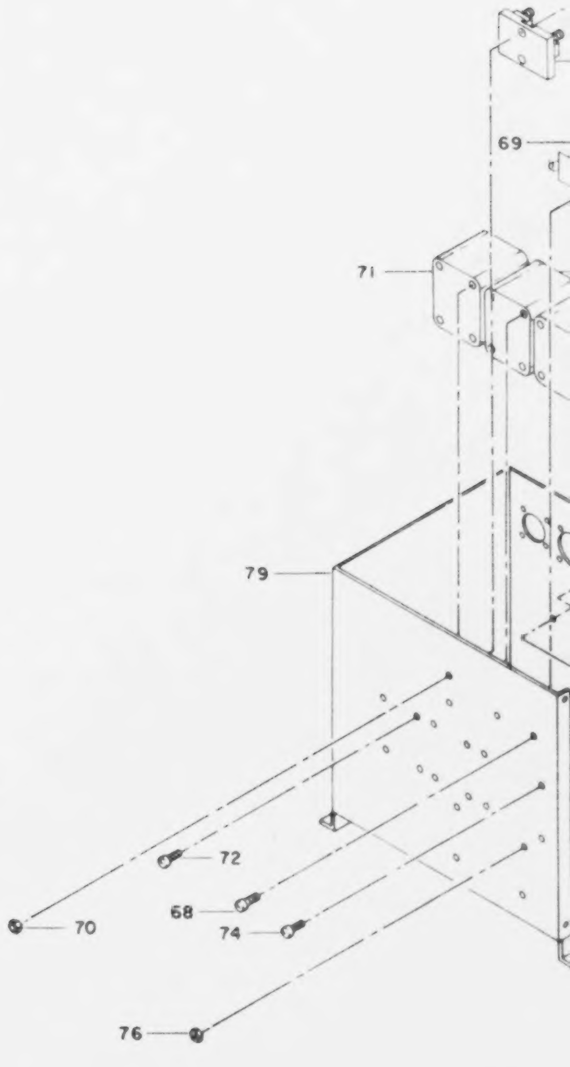
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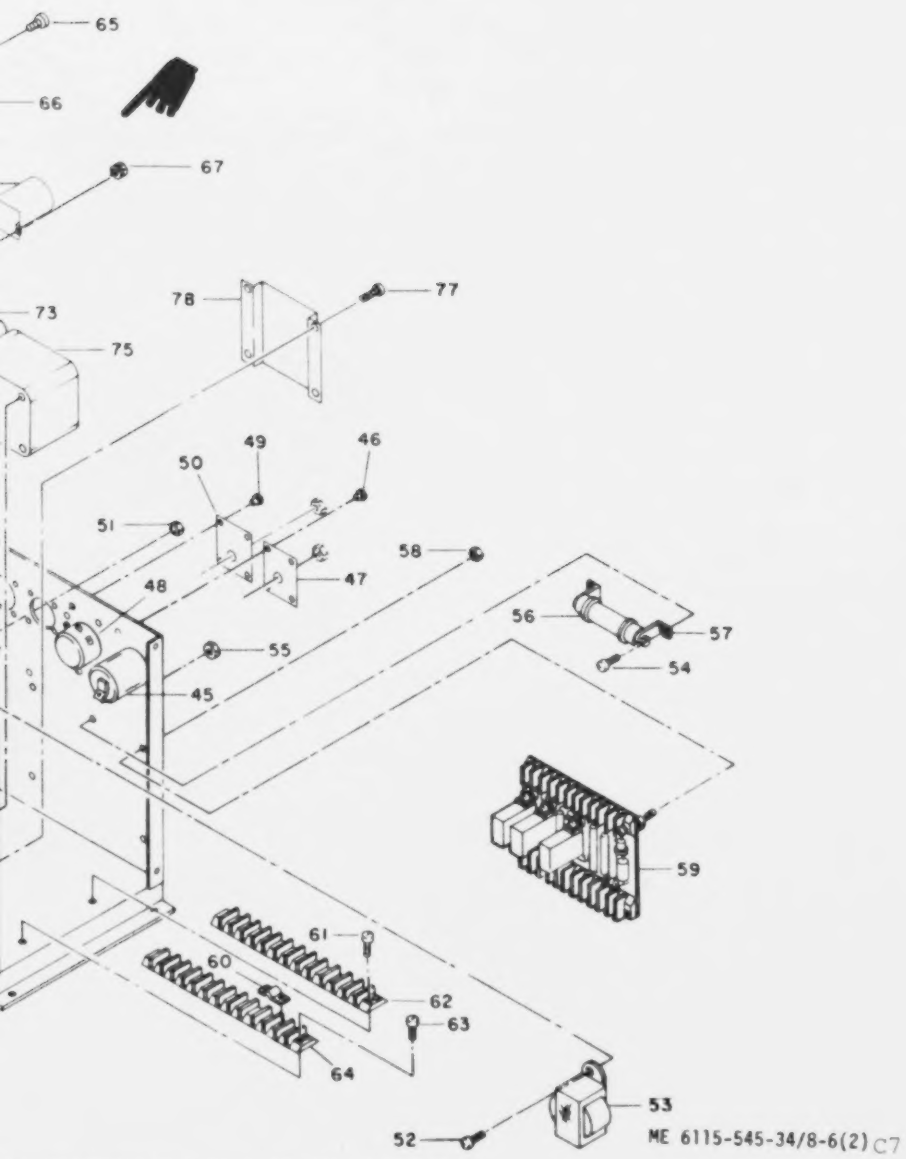
Figure 8-6.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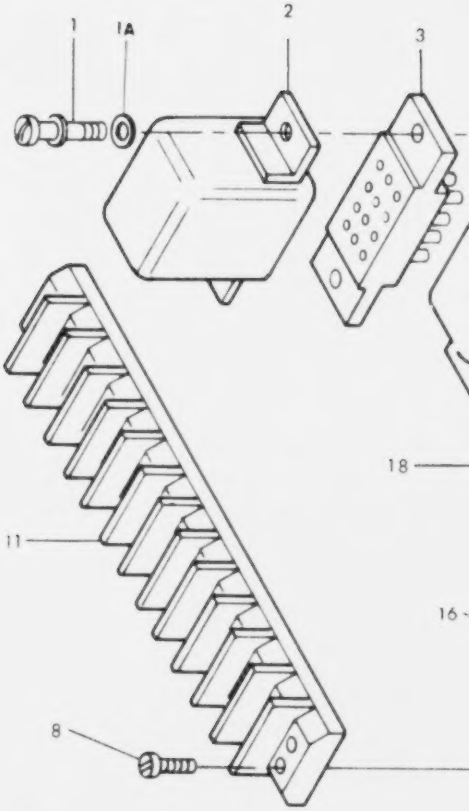
ME 6115-545-34/8-6(2) C7

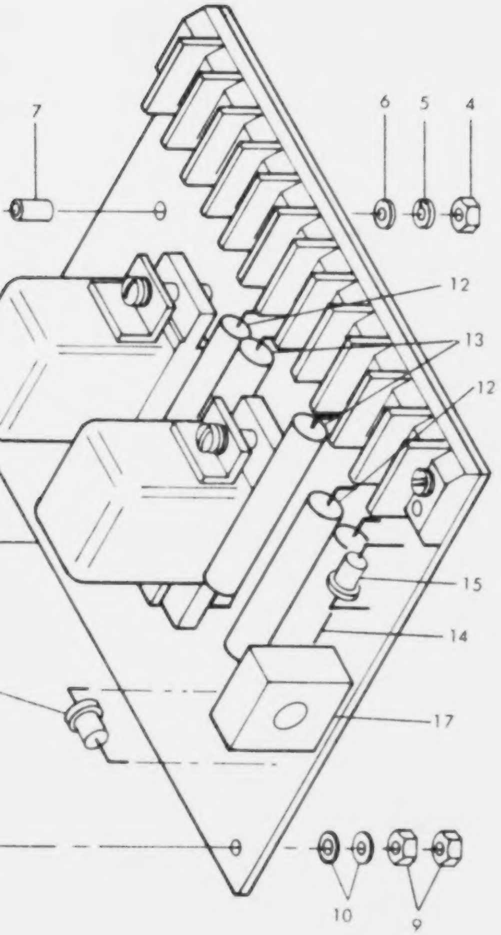
Special Relay Box Assembly (Sheet 2 of 2)


1
1A
2
3
18
11
16
8

1. Screw
1A. Washer
2. Relay (K5, K7, K8)
3. Socket
4. Nut
5. Washer
6. Washer

7. Spacer
8. Screw
9. Nut
10. Washer
11. Termina
12. Resistor

Figure 8-7. DC


7
6
5
4
12
13
12
15
14
17
10
9

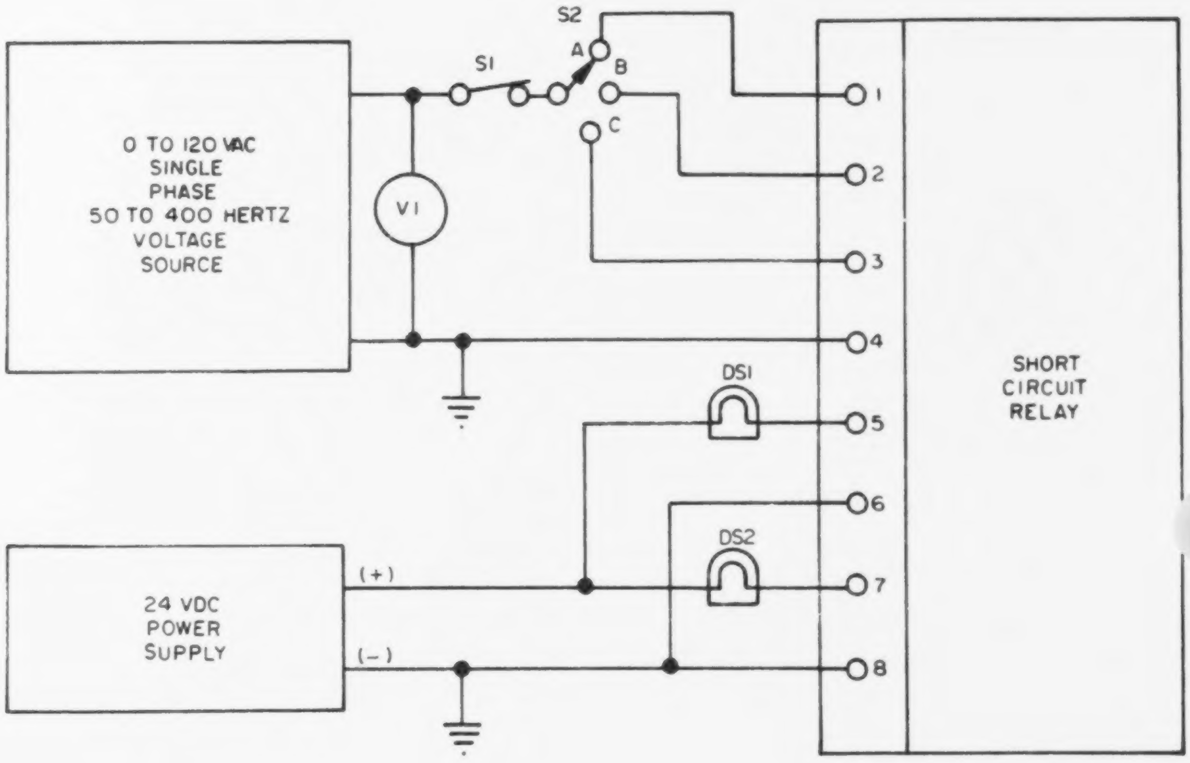
l board

13. Resistor
14. Resistor
15. Diode
16. Diode
17. Rectifier bridge
18. Board

ME 6115-545-34/8-7 C1

Relay Assembly (A5)

| REF DES | DESCRIPTION |
|---|---|
| DS1, DS2 | INDICATOR LIGHT |
| S1 | SWITCH, AC POWER |
| S2 | SWITCH, ROTARY |
| V1 | AC VOLTMETER, 0-120V |


S2
A
B
C
S1
0 TO 120 VAC SINGLE PHASE 50 TO 400 HERTZ VOLTAGE SOURCE
V1
1
2
3
4
DS1
5
6
DS2
7
8
24 VDC POWER SUPPLY
(+)
(-)
SHORT CIRCUIT RELAY

ME 6115-545-34/8-8 C1

Figure 8-8. Short Circuit Relay Test Set-Up

(e) Repeat paragraph (d) for autotransformers T2 and T3. The test results should be the same as for T1. Repeat paragraph (d) for all 3 autotransformers. The test results should be the same.

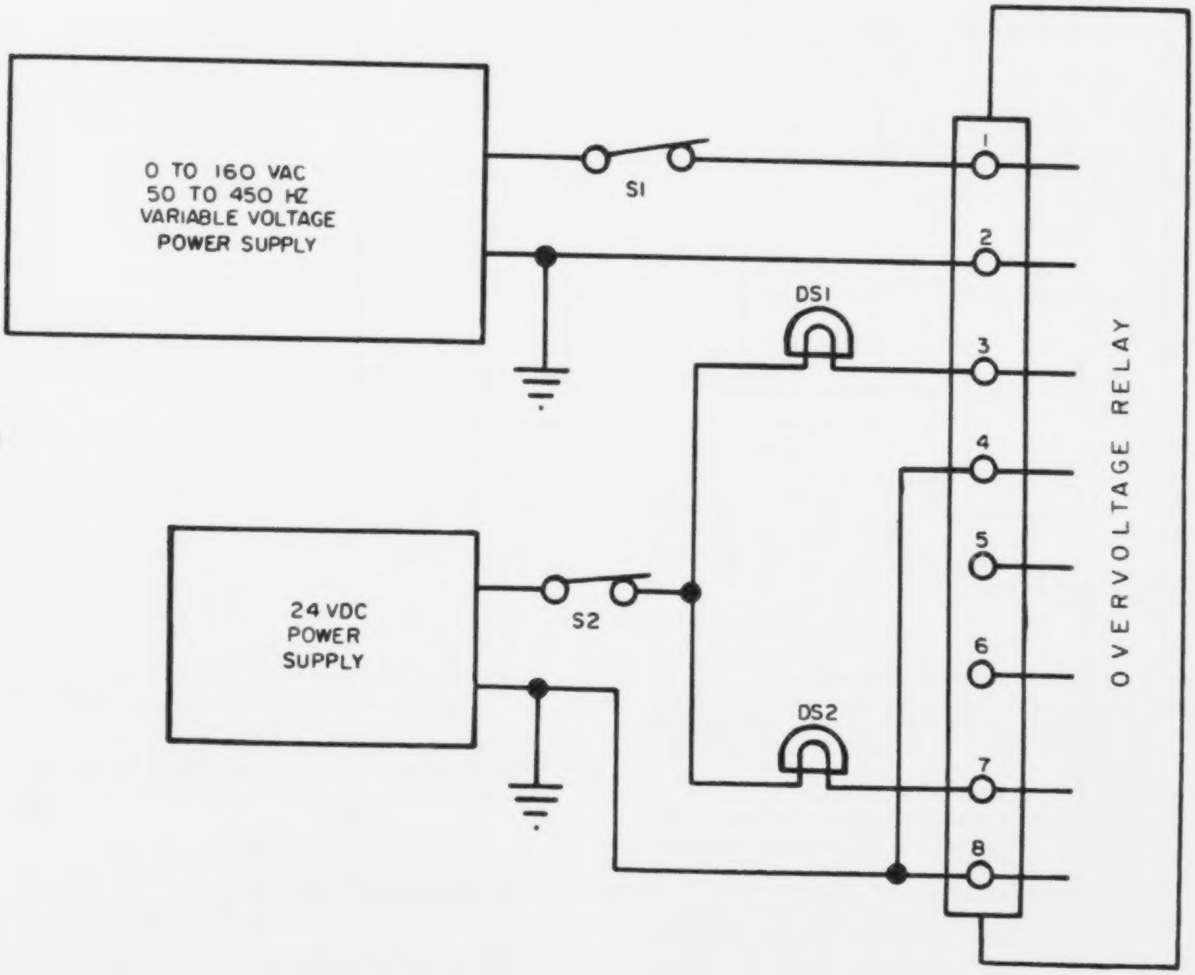
(6) Make a point-to-point check of all wiring and chassis-mounted components. ( See schematic diagrams in Chapter 1.)

b. Precise Relay Box Assembly (Mode I, Cla 1 Sets).

(1) Inspect all components for signs of physical damage.

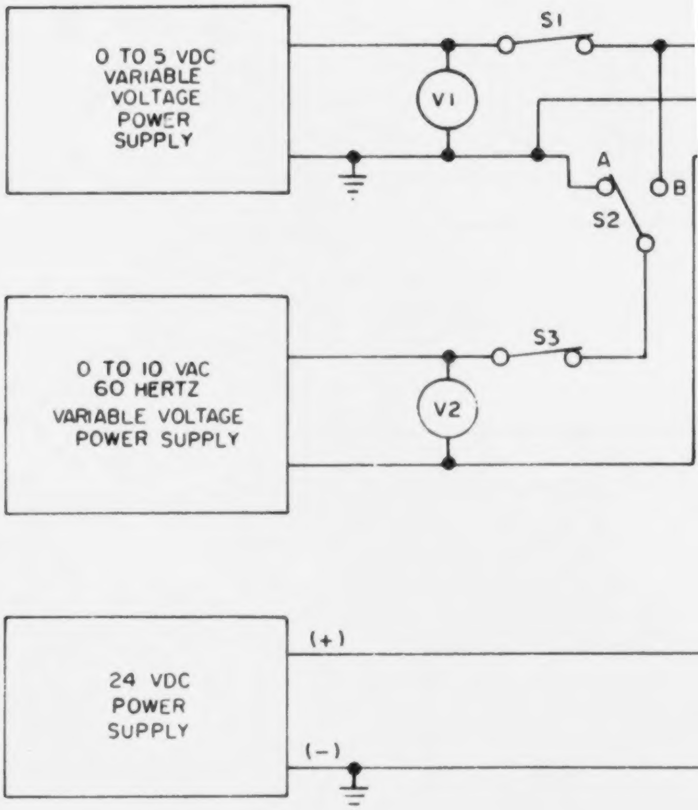
(2) To test the underfrequency relay, see figure 8-12 and test as follows:

| REF DES | DESCRIPTION |
|---|---|
| DS1, DS2 | INDICATOR LIGHT |
| S1 | SWITCH, AC POWER |
| S2 | SWITCH, DC POWER |


0 TO 160 VAC
50 TO 450 HZ
VARIABLE VOLTAGE
POWER SUPPLY
S1
24 VDC
POWER
SUPPLY
S2
DS1
DS2
1
2
3
4
5
6
7
8
OVERVOLTAGE RELAY

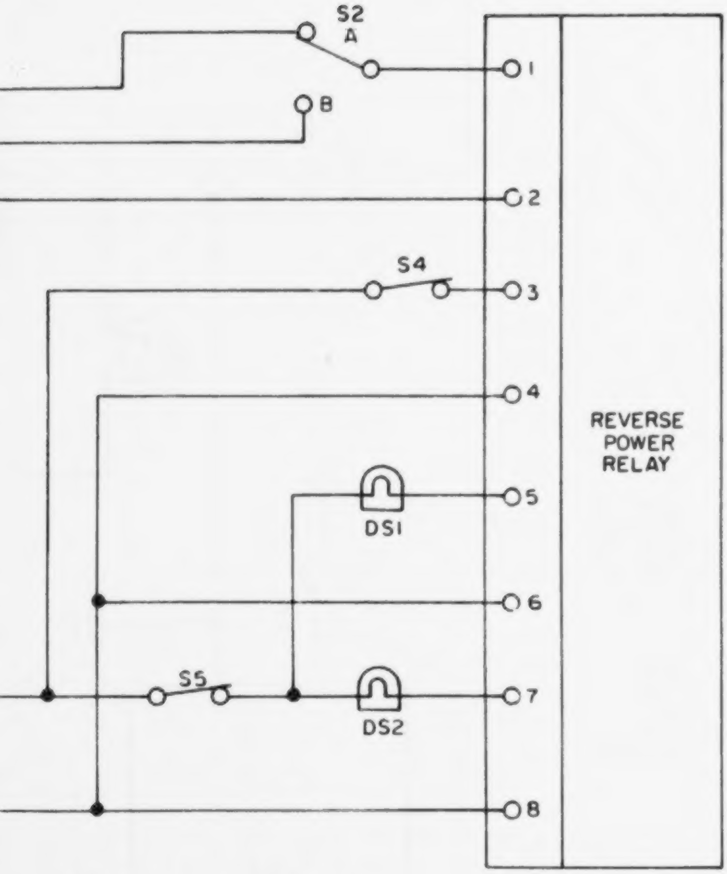
ME 6115-545-34/8-9 C1

Figure 8-9. Overvoltage Relay Test Set-Up


0 TO 5 VDC
VARIABLE
VOLTAGE
POWER
SUPPLY
S1
V1
A
B
S2
0 TO 10 VAC
60 HERTZ
VARIABLE VOLTAGE
POWER SUPPLY
S3
V2
24 VDC
POWER
SUPPLY
(+)
(−)

| REF DES | DESCRIPTION |
|---|---|
| DS1, DS2 | INDICATOR LIGHT |
| S1 | SWITCH, DC POWER |
| S2 | SWITCH, REVERSE POWER |
| S3 | SWITCH, AC POWER |

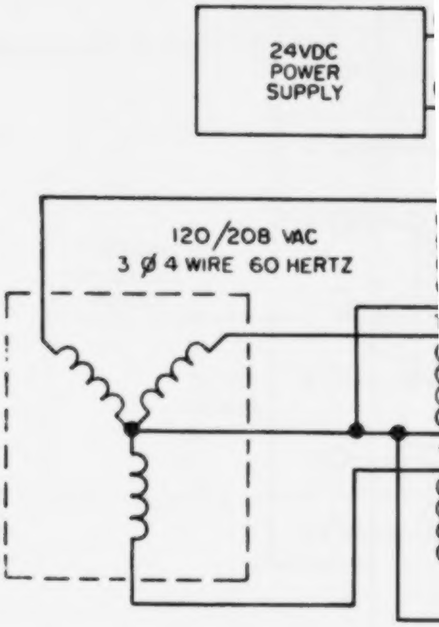
Figure 8-10,


S2
A
B
1
2
S4
3
4
REVERSE POWER RELAY
DS1
5
6
S5
DS2
7
8

| REF DES | DESCRIPTION |
|---|---|
| S4 | SWITCH, DC POWER |
| S5 | SWITCH, DC POWER |
| V1 | DC VOLTMETER |
| V2 | AC VOLTMETER |

ME 6115-545-34/8-10 C1

Reverse Power Relay Test Set-Up



REF

DS1,
R1, R
S1
T1, T

Figure

(a) Connect an external switch acr terminals 7 and 8. Close switch.

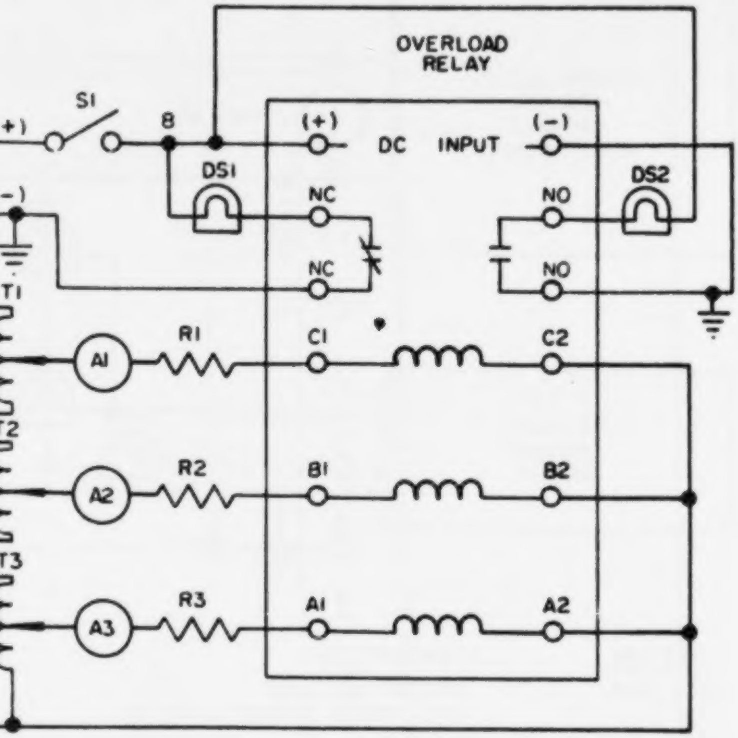
(b) Adjust the frequency to 50 Hz input voltage to 120 volts. Relay contacts s pick up; lamp DS1 should light and DS2 shou tinguish.

(c) Lower frequency slowly until r tacts drop out (lights transfer). Contacts s drop out at 46 ± 1 Hz.

(d) Raise frequency slowly until co pick up (DS1 should light and DS2 should ext Contacts should pick up at 45 to 49 Hz.

(e) Raise voltage to 132 volts and drop out (lights transfer). Drop out should within ± 1 Hz of drop out at 120 volts.

(f) Lower voltage to 108 volts. D (lights transfer) should occur within ± 1 Hz out at 120 volts.



| DES | DESCRIPTION |
|---|---|
| DS2 | INDICATOR LIGHT |
| 2, R3 | RESISTOR, FIXED |
| | SWITCH, DC POWER |
| 2, T3 | 3 PHASE VARIAC |

ME 6115-545-34/8-11 C1

3-11. Overload Relay Test Set-Up

oss

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hould
ld ex-

elay con-
hould

ntacts
nguish).

heck for
ccur

op out
f drop

(g) Open switch between terminals 7 and 8, and adjust input frequency to 60 Hz. Repeat steps (b) through (f). Drop out should occur at 55 ± 1 Hz; pick up at 58 ± 1 Hz.

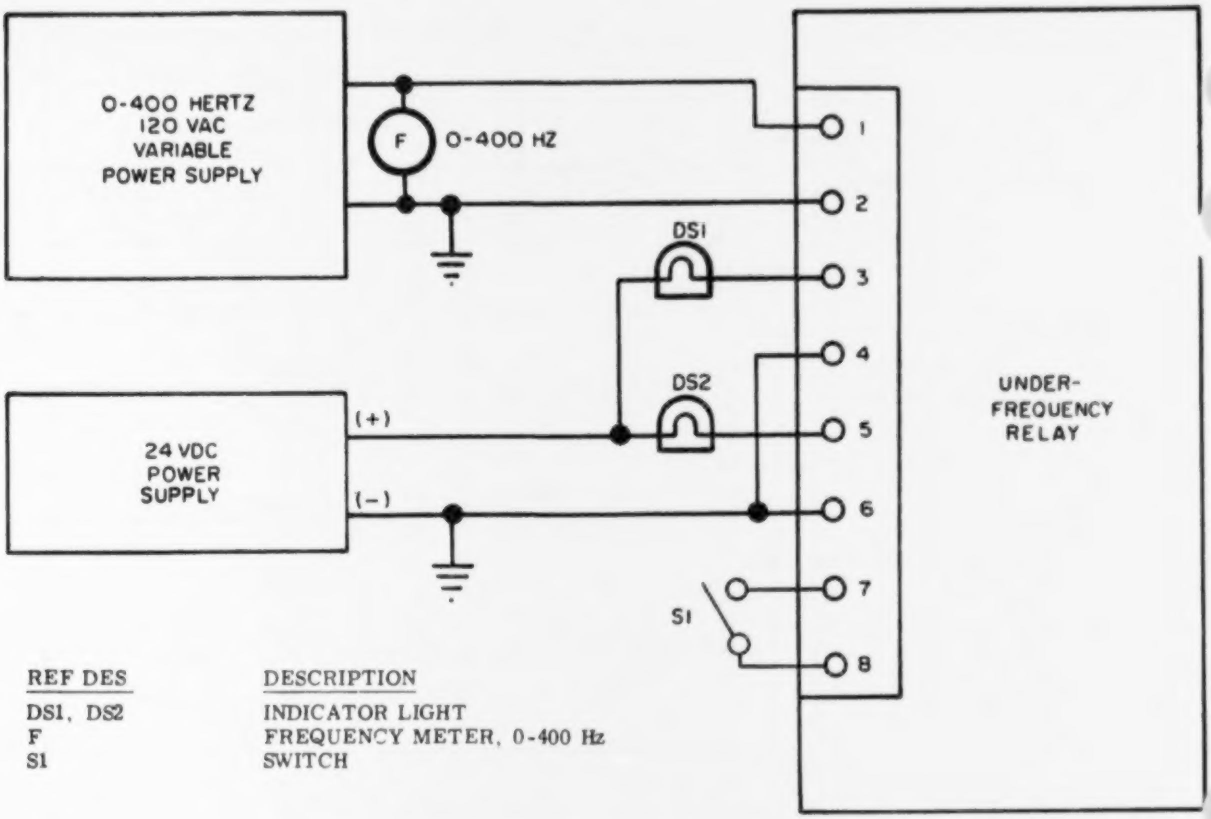
(3) To test the undervoltage relay, see figure 8-13 and refer to paragraph 8-7c(4), but adjust frequency for 50/60 Hz operation.

(4) To test the permissive parallel relay, perform the procedure in paragraph 8-7c(6), but adjust frequency for 50/60 Hz operation.

(4a) To test the resistor assembly (A6), refer to figure 1-7 and proceed as follows:

(a) Check the resistance of R4 between points 1 and 2 on terminal board TB106. Resistance should be 250 ohms.

(b) Check the resistance of R5 between points 3 and 4 on terminal board TB106. Resistance should be 250 ohms.



| REF DES | DESCRIPTION |
|---|---|
| DS1, DS2 | INDICATOR LIGHT |
| F | FREQUENCY METER, 0-400 Hz |
| S1 | SWITCH |

Figure 8-12. Underfrequency Relay Test Set-Up

ME 6115-545-34/8-12 C1

(c) Check capacitor C1 between points 5 and 6 on terminal board TB106. Capacitance should be 60 uf.

(d) Replace components found to be defective.

(4b) Test the total resistance of rheostat (R28). Total resistance should be 15,000 ohms ± 10%. Test resistance between wiper arm and either end of rheostat. Resistance should vary between 0 and 15,000 ohms.

(5) Make a point-to-point check of all wiring and chassis mounted components.

c. Special Relay Assembly.

(1) Check all components for signs of physical damage.

(2) To test the crank relay (K3), apply 24-28 Vdc across the two small terminals and check for continuity across the two large terminals.

(3) See figure 8-12 and connect the underfrequency relay (K12) (Mode II Sets) as shown. Test as follows:

(a) Adjust the frequency to 400 Hz and the input voltage to 120 volts. Relay contacts should "pick up"; lamp DS1 should light and DS2 should extinguish.

(b) Lower frequency slowly until relay contacts drop out (lights transfer). Contacts should drop out at 370 ± 5 Hz.

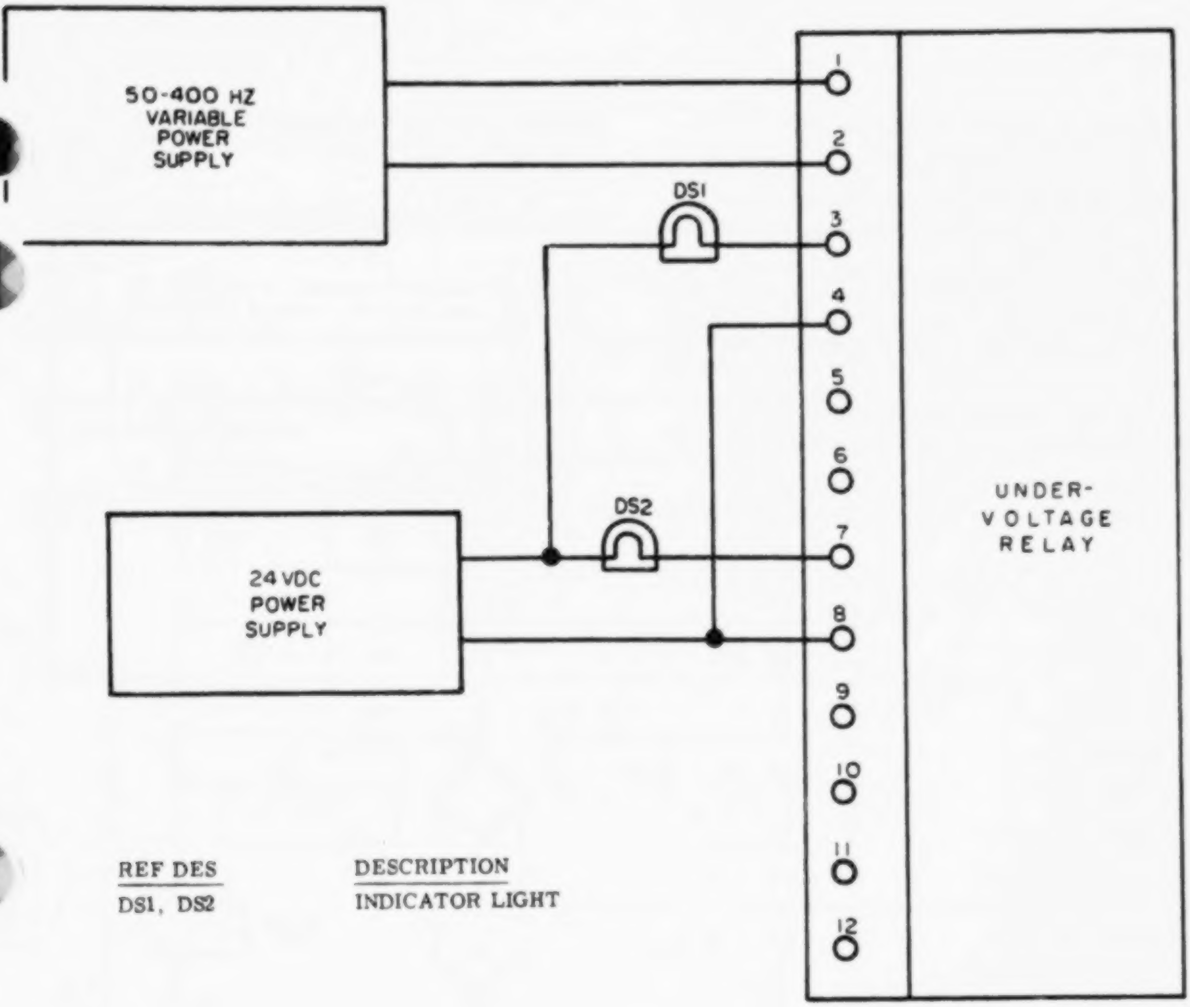
(c) Raise frequency slowly until contacts pick up. DS1 should light and DS2 should extinguish. Contacts should pick up at 370 to 395 Hz.

(d) Raise voltage to 132 volts and check drop out (lights transfer). Drop out should occur within ± 1 cycle of drop out at 120 volts.

(4) To test the undervoltage relay (K11), (Mode II) connect the relay in a test circuit as illustrated in figure 8-13, and proceed as follows:

(a) Adjust ac power supply to 120 volts, 400 Hz. Lamp DS1 should extinguish and DS 2 should light.

(b) Reduce voltage slowly to 104 volts and hold for 2 minutes. Lamp DS1 and DS2 shall maintain states.



| REF DES | DESCRIPTION |
|---|---|
| DS1, DS2 | INDICATOR LIGHT |

Figure 8-13. Undervoltage Relay Test Set-Up

(c) In one step, reduce voltage to 99 volts. DS1 and DS2 shall transfer states within 4 to 8 seconds.

(d) Increase voltage slowly to 113 volts. Lamps DS1 and DS2 shall transfer states.

(e) In one step, lower voltage to 48 volts. Transfer of states of DS1 and DS2 shall be instantaneous.

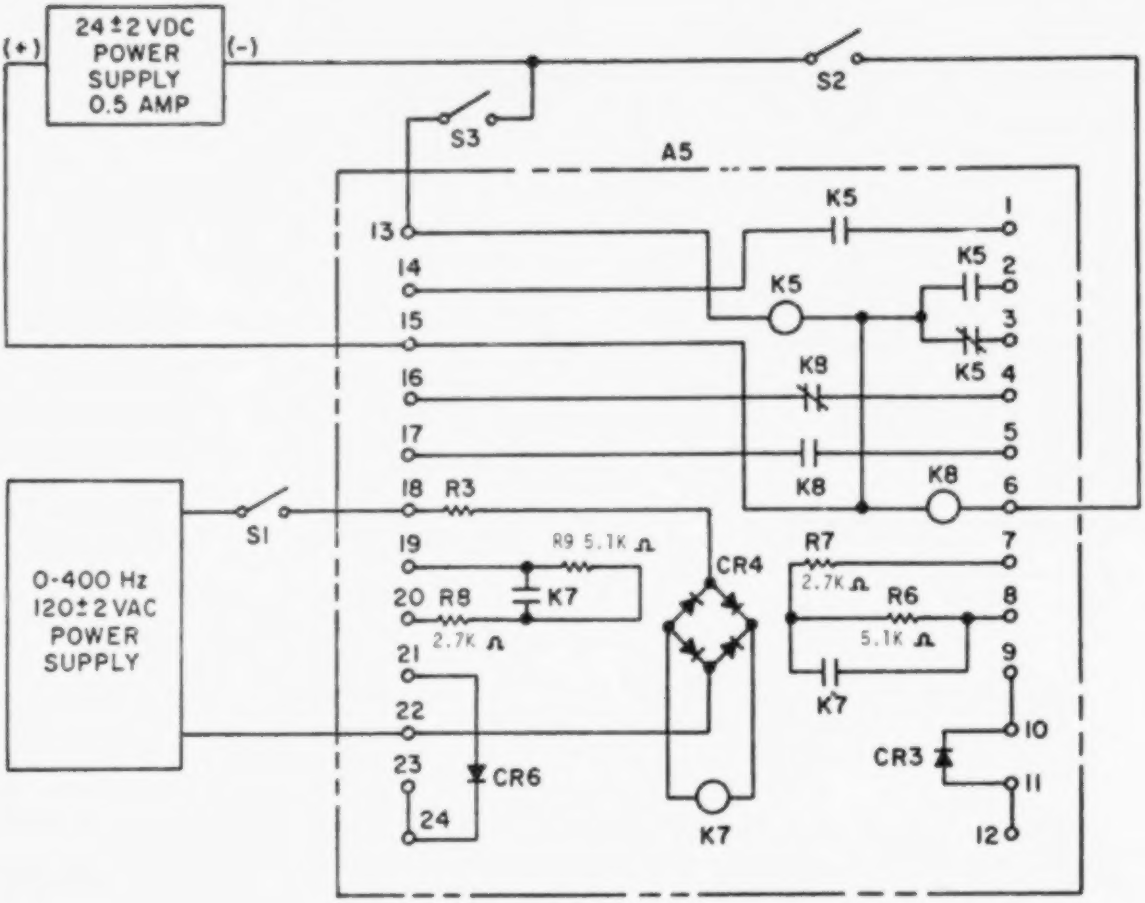
(f) Reduce frequency to 50 Hz and repeat the procedures in paragraphs (a) through (f) with the same results.

(5) To test the DC relay assembly (A5), connect the dc relay assembly in a test circuit as illustrated in figure 8-13A and proceed as follows:

(a) Connect 120 VAC, 400 hertz supply across terminals 18 and 22 of dc relay assembly and close S1 switch. Measure resistance between terminals 7 and 8 and 19 and 20. Measured resistance should be 2500 ohms for both measurements. If this reading is not obtained check for defective resistors R3, R7, R8, defective rectifier CR4 or defective relay K7.

(b) Remove power from assembly and measure resistance between terminals 19 and 20, and 7 and 8 of dc relay assembly. Resistance should be 7500 ohms for both measurements. If this reading is not obtained check for defective relay K7.

(c) Check continuity between terminals 11 and 10 and 21 and 23. (Ohmmeter + lead placed on terminals 11 and 21). There should be continuity. If there is no continuity check for defective diode CR3 or CR6.



24±2VDC POWER SUPPLY 0.5 AMP
(+)
(-)
S2
S3
A5
K5
13
14
15
16
17
18
19
20
21
22
23
24
1
2
3
4
5
6
7
8
9
10
11
12
K5
K5
K5
K8
K8
K8
R3
S1
0-400 Hz 120±2VAC POWER SUPPLY
R9 5.1K Ω
K7
R8
2.7K Ω
CR4
R7
2.7K Ω
R6
5.1K Ω
K7
CR3
CR6
K7

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Figure 8-13A. DC Relay Assembly (A5) Test Setup

(d) Connect 24 vdc across terminals 6 (-) and 15 (+) and close S2 switch. There shouldn't be continuity between terminals 4 and 16, and there should be continuity between terminals 5 and 17. If this is not obtained, check for defective relay K8.

(e) Remove 24 vdc from terminals 6 and 15 and connect across terminals 13 and 15 and close S3 switch. Measured voltage between terminals 2 and 13 should be 24 vdc; zero between terminals 3 and 13. Continuity should exist between terminals 1 and 14. If these readings are not obtained, check for defective relay K5.

(6) To test the permissive parallel relay (K16) (Mode II Sets), see figure 8-14 and test as follows:

(a) Apply 24 Vdc to terminals 3 (+) and 4 (-).

(b) Apply 20 volts, 400 Hz across terminals 1 and 2.

(c) Normally open contacts 5 and 6, and normally closed contacts 7 and 8 must transfer.

(d) Slowly decrease the voltage at terminals 1 and 2. The relay must reset when the voltage is 8 ± 1 volt ac.

(7) To test the current transformer, proceed as follows:

(a) Connect an ohmmeter across terminals 1 and 2, and across 3 and 4. In each case, the resistance must be 0.34 ohms ± 10 percent.

(b) Apply 15 Vac to terminals 1 and 2 with secondary open circuit. The existing current must be less than 0.24 ampere.

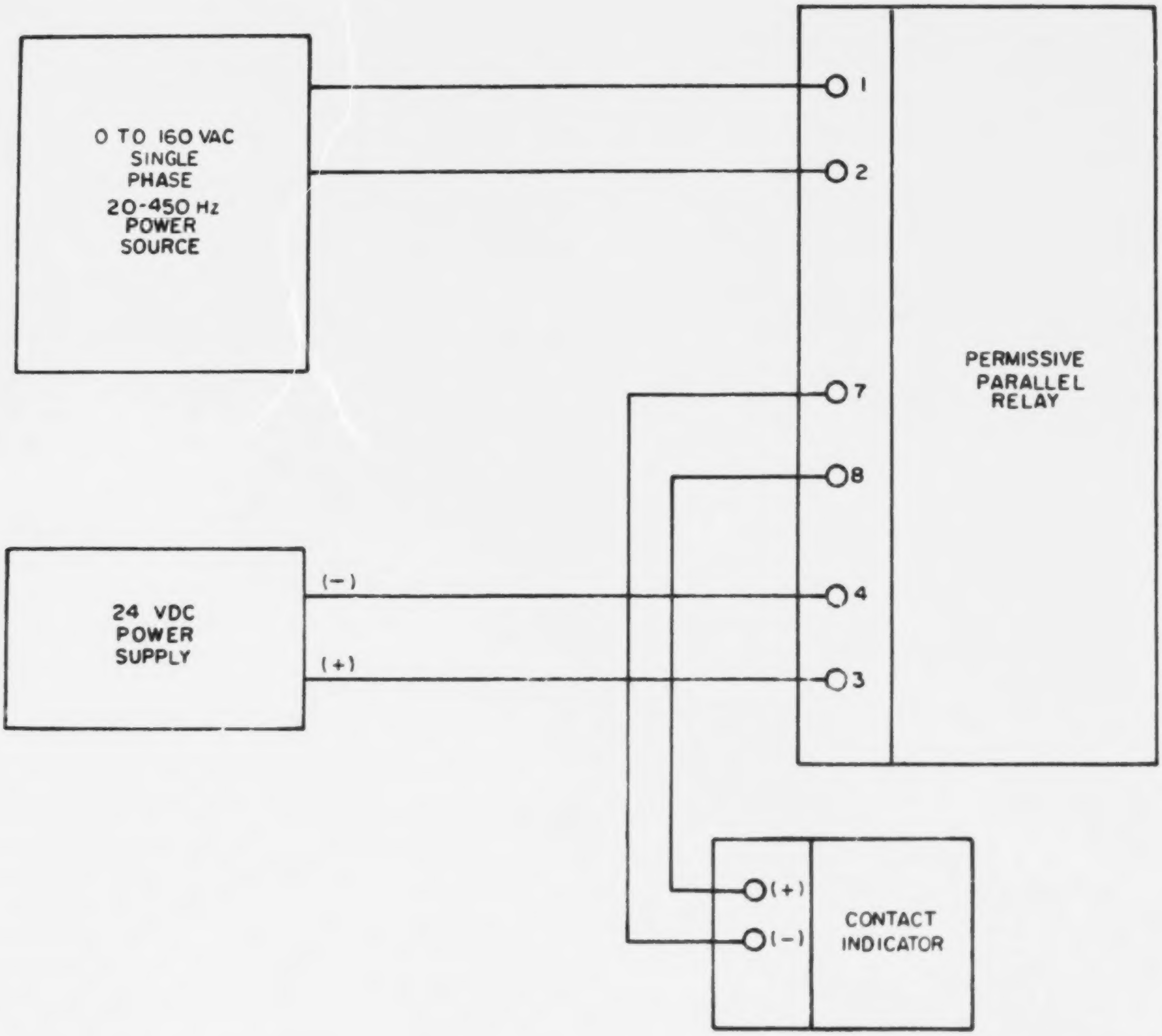
(c) Apply 15 Vac to terminals 1 and 2 with secondary open circuit. The voltage across terminals 3 and 4 must be 15 volts ac ± 1 percent.

(7a) Test the total resistance of rheostat (R28), (Mode II). Total resistance should be 15,000 ohms ± 10%. Test resistance between wiper arm and either end of rheostat. Resistance should vary between 0 and 15,000 ohms.

(7b) Test the total resistance of rheostat (R29). Total resistance should be 12 ohms. Test resistance between wiper arm and either end of rheostat. Resistance should vary between 0 and 12 ohms.

(7c) To test resistor assembly (A6) (Mode II) refer to paragraph (4a) and proceed as instructed.

(7d) Check resistance of resistor (R31). Resistance should be 10 ohms.


0 TO 160 VAC
SINGLE
PHASE
20-450 Hz
POWER
SOURCE
24 VDC
POWER
SUPPLY
(−)
(+)
1
2
7
8
4
3
PERMISSIVE
PARALLEL
RELAY
(+)
(−)
CONTACT
INDICATOR

ME 6115-545-34/8-14 C1

Figure 8-14. Permissive Parallel Relay Test Set-Up

(7e) To test shunt (R13), apply 20 amperes to input of shunt and measure output with a millivoltmeter. Output should be 50 millivolts.

(8) Make a point-to-point check of all wiring and chassis mounted components. (See schematic diagrams in Chapter 1.)

8-8. Repair, Reassembly, and Installation.

a. Repair.

(1) Replace any relay found to be defective during testing.

(2) Replace all defective diodes, resistors, and transformers.

(3) If any connections are opened or bared for test purposes, or if any defective components are replaced the effected area and component must be coated with polyurethane resin to prevent oxidation or other corrosion. The coating must be of a minimum thickness of 0.007 inches and air bubble entry into the applied polyurethane must be controlled so that the legibility of component coding and identification is not impaired.

(4) Replace defective connectors.

(5) Repair or rebuild wiring harnesses as required. See wiring schematics in Chapter 1 and wiring harness diagrams in Chapter 5.

b. Reassembly.

(1) See figure 8-6 and 8-7 and paragraph 8-6c and reassemble the special relay box assemblies in reverse order of disassembly. The dc relay assembly will be coated in accordance with the requirements of paragraph 3-3c(5).

(2) See figures 8-4 and 8-5 to reassemble the precise relay assembly.

(3) See figures 8-2 and 8-3 to reassemble the tactical relay assembly. Rewire relay resistor assembly as shown in figure 8-3.

c. Installation.

(1) See figure 8-1 and install special relay box, precise, and tactical relay assemblies on the relay table.

(2) See figure 8-1 and install relay table.

## Section III. EXCITATION SYSTEM ASSEMBLY

### 8-9. Scope.

This section contains repair and adjustment instructions for the excitation assembly exciter.

### 8-10. Removal.

See figure 8-1 and remove the excitation assembly exciter (18) as follows:

a. Unscrew the two electrical connectors.

b. Remove screws (19) which secure exciter (18) to relay table (52).

### 8-11. Disassembly.

NOTE

Tag all electrical leads removed during disassembly for positive identification during reassembly.

a. Excitation Assembly Exciter. To disassemble excitation assembly exciter. See figure 8-15 and proceed as follows:

(1) Remove screws (1) which secure cover (2) to chassis (3) and remove cover.

(2) Remove screws (4) which secure harness connector to chassis (3).

(3) Unscrew connector from voltage regulator (8).

(4) Remove screw (9) and clamp (10).

(5) Tag and disconnect all electrical leads and remove wiring harness (6).

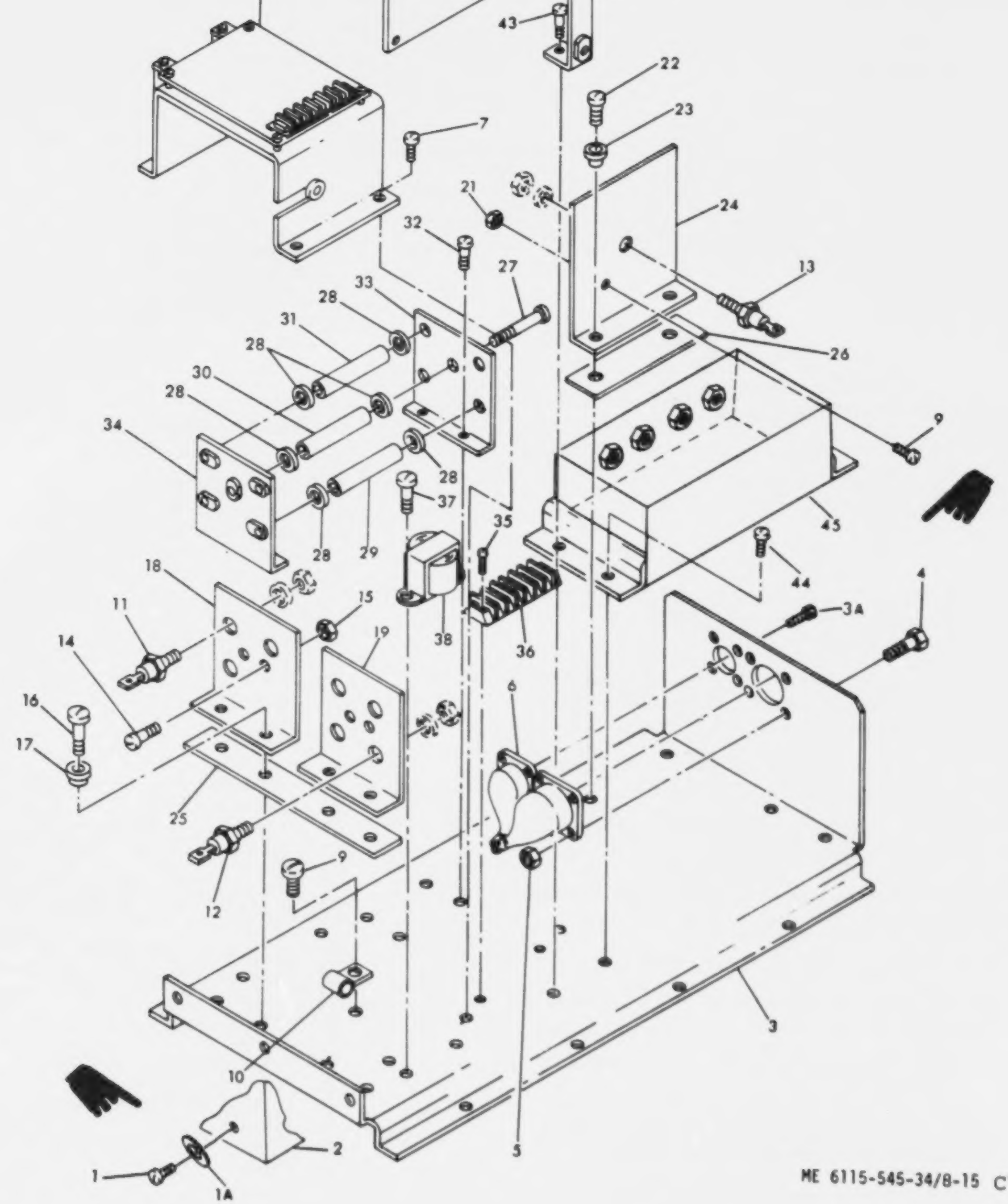
(6) Remove semiconductors (11, 12 and 13).

**(7) Remove heatsinks (18, 19, and 24) by removing associated hardware (14 thru 17 and 20 thru 23) and remove insulators (25 and 26).**

(8) Remove resistors (29, 30 and 31) by removing screws (27) and washers (28).

**Key** to fig. 8-15.

1. Screw
1A. Washer
2. Cover
3. Chassis
3A. Screw
4. Screw
5. Nut
6. Wire harness assy
7. Screw
8. Voltage regulator (A10)
9. Screw
10. Clamp
11. Semiconductor
12. Semiconductor
13. Semiconductor
14. Screw
15. Nut
16. Screw
17. Washer
18. Heatsink
19. Heatsink
20. Screw
21. Nut
22. Screw
23. Washer
24. Heatsink
25. Insulator
26. Insulator
27. Screw
28. Washer
29. Resistor
30. Resistor
31. Resistor
32. Screw
33. Bracket
34. Bracket
35. Screw
36. Terminal block
37. Screw
38. Transformer
39. Screw
40. Electronic component assy
41. Spacer
42. Bracket
43. Screw
44. Screw
45. Filter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34
28
37
28
29
45
35
18
11
15
19
38
36
44
3A
4
14
16
6
17
25
12
9
10
3
5
2
1
1A

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Figure 8-15. Excitation System Assembly

(9) Remove screws (32) which secure brackets (33 and 34) to chassis (3) and remove brackets.

(10) Remove screws (35) which secure terminal board (36) to chassis (3) and remove terminal board.

(11) Remove screws (37) which secure transformer (38) to chassis (3) and remove transformer.

(12) Remove screws (39) which secure electronic component assembly (40) to bracket (42) and remove electronic component assembly and spacers (41).

(13) Remove screws (43) which secure brackets (42) to chassis (3) and remove brackets.

(14) Remove screws (44) which secure filter (45) to chassis (3) and remove filter.

b. **Voltage Regulator.** See figure 8-16 to disassemble the voltage regulator.

c. **Voltage Regulator Printed Circuit Board Assembly. See figure 8-17 to disassemble the voltage regulator printed circuit board assembly.**

d. **Electronic Component Assembly.** See figure 8-18 to disassemble the electronic component assembly.

### 8-12. Inspection and Testing.

a. Inspection. Proceed as follows:

(1) Inspect the complete assembly and all components for signs of physical damage.

(2) Inspect electrical components for signs of overheating.

b. Testing. See figure 1-8 and proceed as follows:

(1) Disconnect diodes CR201 through CR206 from heat sinks and test each diodes per paragraph 14-10.

(2) Refer to table 8-2. Disconnect one side of each resistor, and use ohmmeter to check resistance.

(3) Check A201 RFI filter by disconnecting filter leads and checking resistance across terminals 1 and 1A, and across terminals 2 and 2A. Resistance should be less than two ohms.

(4) Check SCR (Q205) as follows:

(a) Disconnect lead from terminal 1 of voltage regulator circuit card assembly.

(b) Set ohmmeter to R1 scale. Connect meter positive lead to stud of SCR and negative lead to large terminal of SCR. Ohmmeter should indicate open circuit. Reverse leads.

(c) Short small terminal (gate) of SCR to ground. Ohmmeter, connected as in (b), should read between 10 and 40 ohms.

(5) Check voltage regulator and electronic component circuit board assemblies as follows:

(a) Interconnect excitation system assembly to test setup as shown in figure 8-19.

(b) Adjust variac for 70 volt ac input indication on ac voltmeter. Dc voltmeter should read approximately 25 volts.

(c) Increase ac input to 80 volts. Dc voltmeter should increase proportionally and read approximately 30 volts.

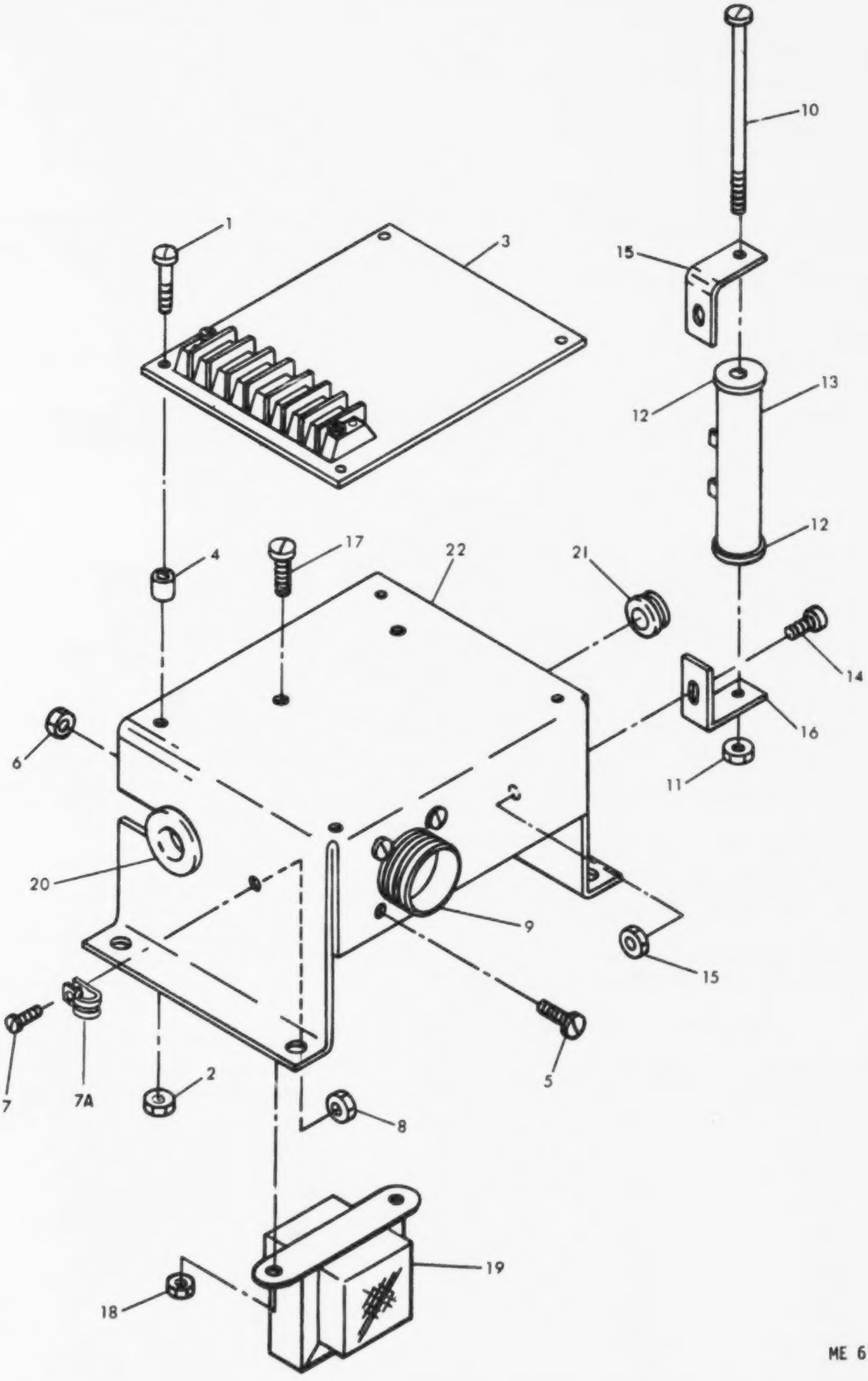
(d) Increase ac input gradually. At approximately 95 volts input, dc voltmeter should drop to zero (indicating zero field voltage output). If dc voltage does not drop to zero, replace both the electronic component and voltage **regulator** circuit boards and repeat steps (a), (b), (c), and (d).

(6) See figure 1-8 and check the 50/60 Hz electronic component assembly as follows:

(a) Connect one end of a 1000 ohm 1/2 watt carbon resistor to terminal 4.

Table 8-2. Excitation Assembly Resistor Values

| Reference Designation | Mode I Sets (50/60 Hz) (ohms) | Mode II Sets (400 Hz) (ohms) | Reference Designation | Mode I Sets (50/60 Hz) (ohms) | Mode II Sets (400 Hz) (ohms) |
|---|---|---|---|---|---|
| R201 | 220 | 220 | R215 | 150 | 150 |
| R202 | 2000 | 2000 | R216 | 1000 | 1000 |
| R203 | 100 | 100 | R217 | 1000 | 1000 |
| R204 | 3300 | 3300 | R218 | 5100 | 5100 |
| R205 | 680 | 680 | R219 | 15 | 6.8 |
| R206 | 100 | 100 | R220 | 5000 | 5000 |
| R207 | 1000 | 1000 | R221 | 30 | 30 |
| R208 | 1000 | 1000 | R222 | 30 | 30 |
| R209 | 1000 | 1000 | R223 | 30 | 30 |
| R210 | 2700 | 2700 | R224 | 0.5 | 0.5 |
| R211 | 50000 | 50000 | R225 | 300 | 300 |
| R212 | 10000 | 10000 | R226 | 100 | 100 |
| R213 | 3000 | 3000 | R227 | 120 | 120 |
| R214 | 5000 | 5000 | | | |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22
21
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16
11
6
20
9
15
5
7
7A
2
8
19
18

1. Screw
2. Nut
3. Circuit card assy
4. Standoff
5. Screw
6. Nut
7. Screw
7A. Clamp
8. Nut
9. Wire harness assy
10. Screw
11. Nut
12. Washer
13. Resistor
14. Screw
15. Nut
16. Bracket
17. Screw
18. Nut
19. Transformer
20. Grommet
21. Grommet
22. Chassis

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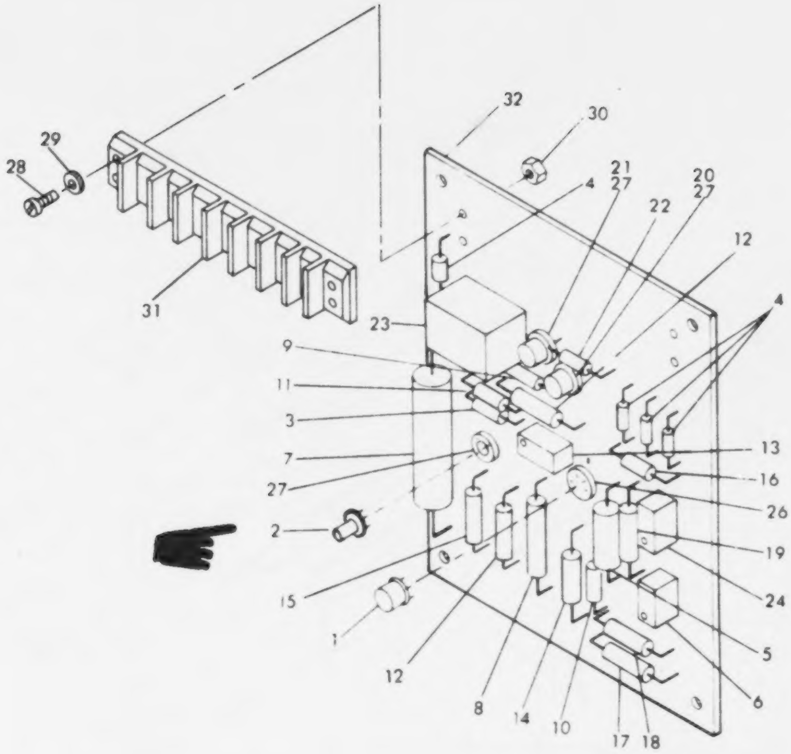
Figure 8-16. Voltage Regulator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27
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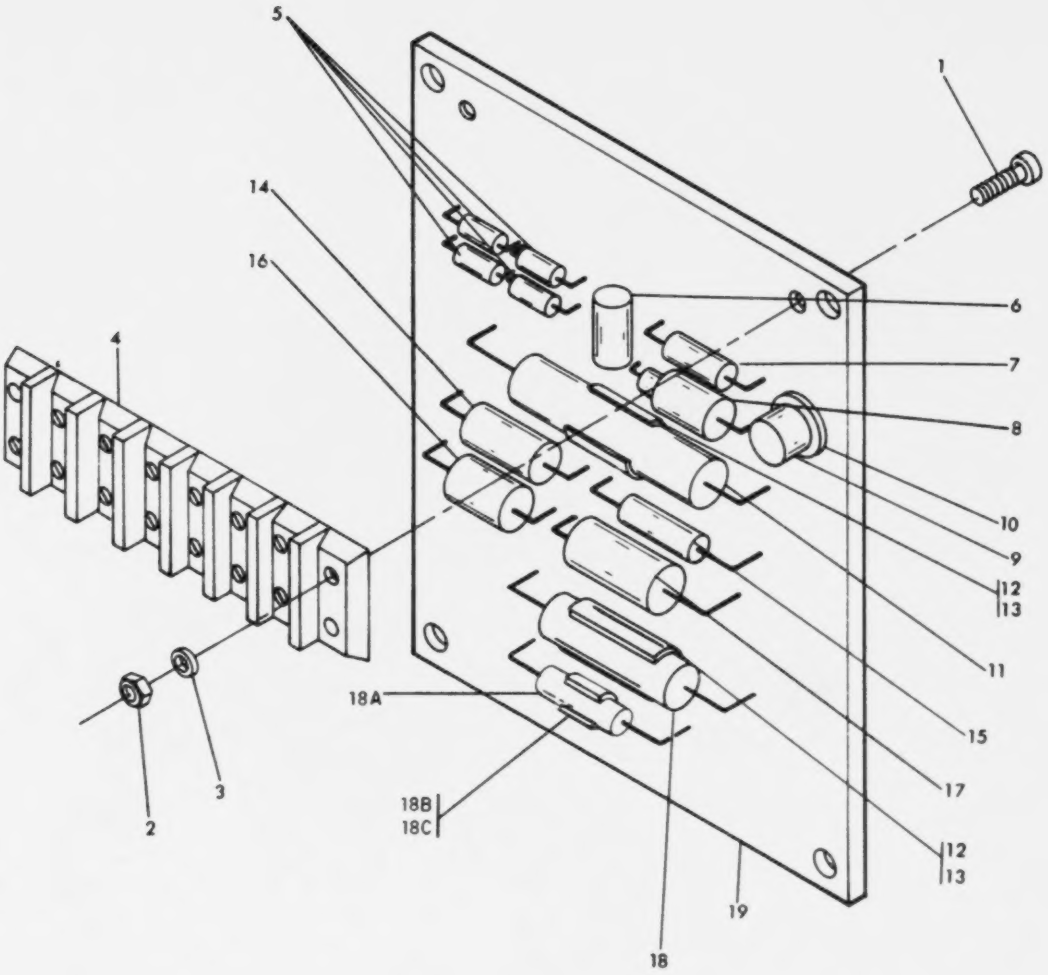
23
9
11
3
7
27
2
15
1
12
8
14
10
17
18
6
5
24
19
26
16
13
4

1. Transistor
2. Transistor
3. Semiconductor
4. Semiconductor
5. Semiconductor
6. Resistor
7. Capacitor
8. Capacitor
9. Resistor
10. Resistor
11. Resistor
12. Resistor
13. Resistor
14. Resistor
15. Resistor
16. Resistor
17. Resistor
18. Resistor
19. Resistor
20. Transistor
21. Transistor
22. Resistor
23. Transformer
24. Resistor
25. (Deleted)
26. Transipad
27. Transipad
28. Screw
29. Washer
30. Nut
31. Terminal board
32. Printed circuit board

ME 6115-545-34/8-17 C7

Figure 8-17. Voltage Regulator Printed Circuit Board Assembly



1. Screw
2. Nut
3. Washer
4. Terminal block
5. Semiconductor
6. Resistor
7. Resistor
8. Semiconductor
9. Transistor
10. Pad
11. Capacitor
12. Clip
13. Eyelet
14. Capacitor
15. Resistor
16. Resistor
17. Resistor
18. Capacitor
18A. Capacitor
18B. Clip
18C. Eyelet
19. Printed circuit board

ME 6115-545-34/8-18 C1

Figure 8-18. Electronic Component Assembly

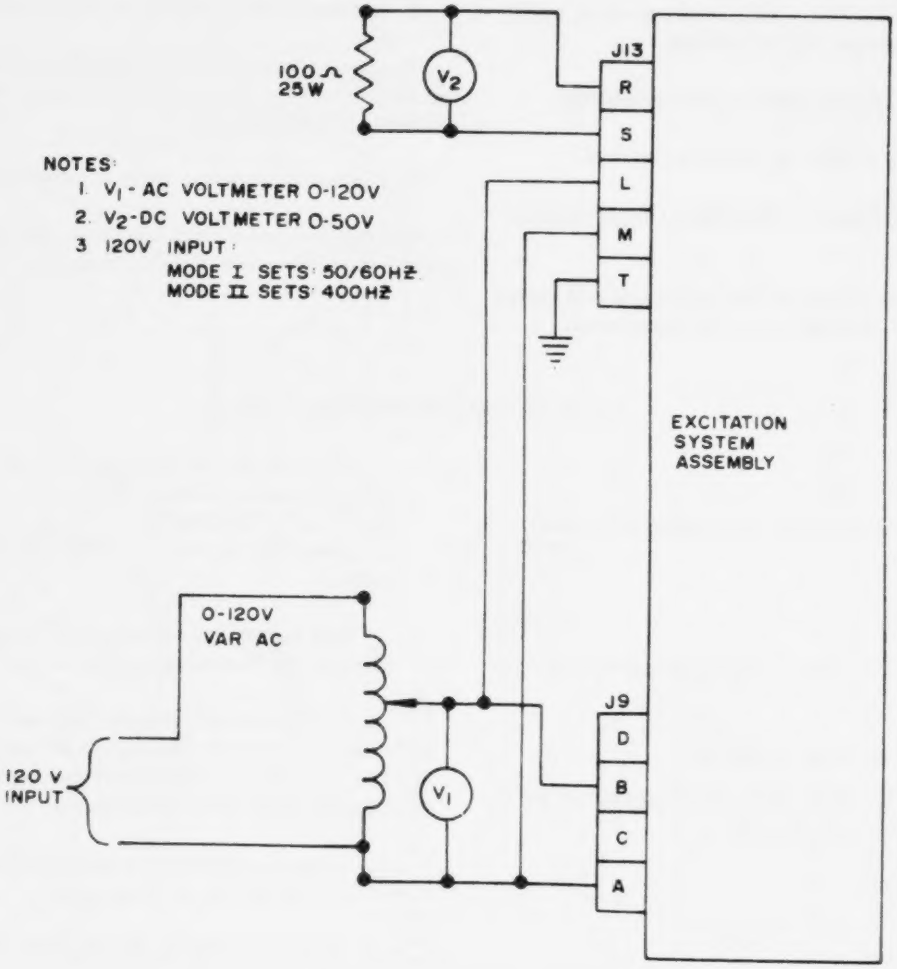
(b) Connect the positive output terminal (4) of a variable 24 Vdc power supply to the other end of the resistor. Connect the negative (-) terminal of the power supply to terminal 3.

(c) Connect a variable 100 Vac power supply to terminals 1 and 2.

(d) Adjust the dc power supply voltage to 10 volts.

(e) Slowly raise the ac power supply to 37 volts rms. The dc voltage at terminals 3 and 4 shall drop sharply to below 1 volt.

(f) For the 400 Hz electronic component assembly, repeat steps (a) thru (e) using a 400 Hz variable ac power supply.


100Ω
25W
V2
J13
R
S
L
M
T
NOTES:
1. V1 - AC VOLTMETER 0-120V
2. V2-DC VOLTMETER 0-50V
3 120V INPUT:
MODE I SETS: 50/60HZ
MODE II SETS: 400HZ
EXCITATION
SYSTEM
ASSEMBLY
0-120V
VAR AC
J9
D
B
C
A
120 V
INPUT
V1

ME 6115-545-34/8-19

Figure 8-19. Excitation Assembly System Test Set-Up

8-13. Repair, Reassembly and Installation.

a. Repair.

(1) Relay circuit board assemblies found to be defective during testing.

(2) Replace all defective diodes, resistors, and transformers.

(3) Replace defective connectors.

(4) Repair or rebuilt wiring harnesses as required. See wiring schematics in Chapter 1 and wiring harness diagrams in Chapter 5.

b. Reassembly.

(1) See figure 8-18 to reassemble the electronic component assembly.

(2) See figure 8-16 and 8-17 to reassemble the voltage regulator assembly.

(3) See figure 8-15 and refer to paragraph 8-11, and reassemble the excitation system assembly in reverse order of disassembly.

c. Installation. See figure 8-1 and refer to paragraph 8-10 to install the excitation system assembly.

8-14. Adjustments.

After the excitation system assembly is reinstalled, perform the following operational adjustments:

a. Voltage Adjustment

(1) With Voltage Adjust control on generator control panel set at approximately midpoint, start generator set.

(2) Adjust Set Point (R212) control to obtain rated voltage at generator output terminals.

b. Stability. Adjust R207 for optimum stability.

c. Gain. Adjust R211 for 14 K ohms nominal.

d. Parallel Adjustment Procedures - Reactive Load Sharing.

(1) Connect an external load bank capable of loading the generator set to full load at 0.8 power factor.

(2) Perform checks in accordance with paragraph 16-11.

e. Equipment Test. If the excitation assembly has been replaced, repaired or adjusted refer to Chapter 16, Section II and conduct the following tests.

(1) Regulation range test. Refer to paragrpah 16-14.

(2) Frequency and voltage regulation, stability and transient response test, short term. Refer to paragraph 16-15.

## Section IV. LOAD MEASURING UNIT

### 8-15. Scope.

This section contains repair instructions for the load measuring unit.

### 8-16. Removal.

See figure 8-1 and remove the load measuring unit (7) as follows:

a. Unscrew electrical connector.

b. Remove screws (5) which secure load measuring unit (7) to bottom of relay table (52).

### 8-17. Disassembly.

NOTE

Tag all electrical leads removed during disassembly for positive identification during reassembly.

See figure 8-20 to disassemble the load measuring unit.

### 8-18. Testing.

a. Connect load measuring unit in test circuit as illustrated in figure 8-21.

b. With 120 volts on M3, no load on load bank (Rd), and 0 volts indicated on voltmeter (M1), voltmeter (M2) shall indicate 0 to 0.4 Vdc. Resistor R1 (17, fig. 8-20), internal to load measuring unit, may be adjusted to obtain this reading.

c. With load on Rd, and 5.6 volts ac indicated on M1, voltmeter M2 shall indicate 9.4 to 9.8 Vdc.

d. Select intermediate loads of Rd, and observe that the voltage relationships indicated by M1 and M2 are identical to the relationships indicated by the graph in figure 8-22. Adjust R1 to obtain this relationship.

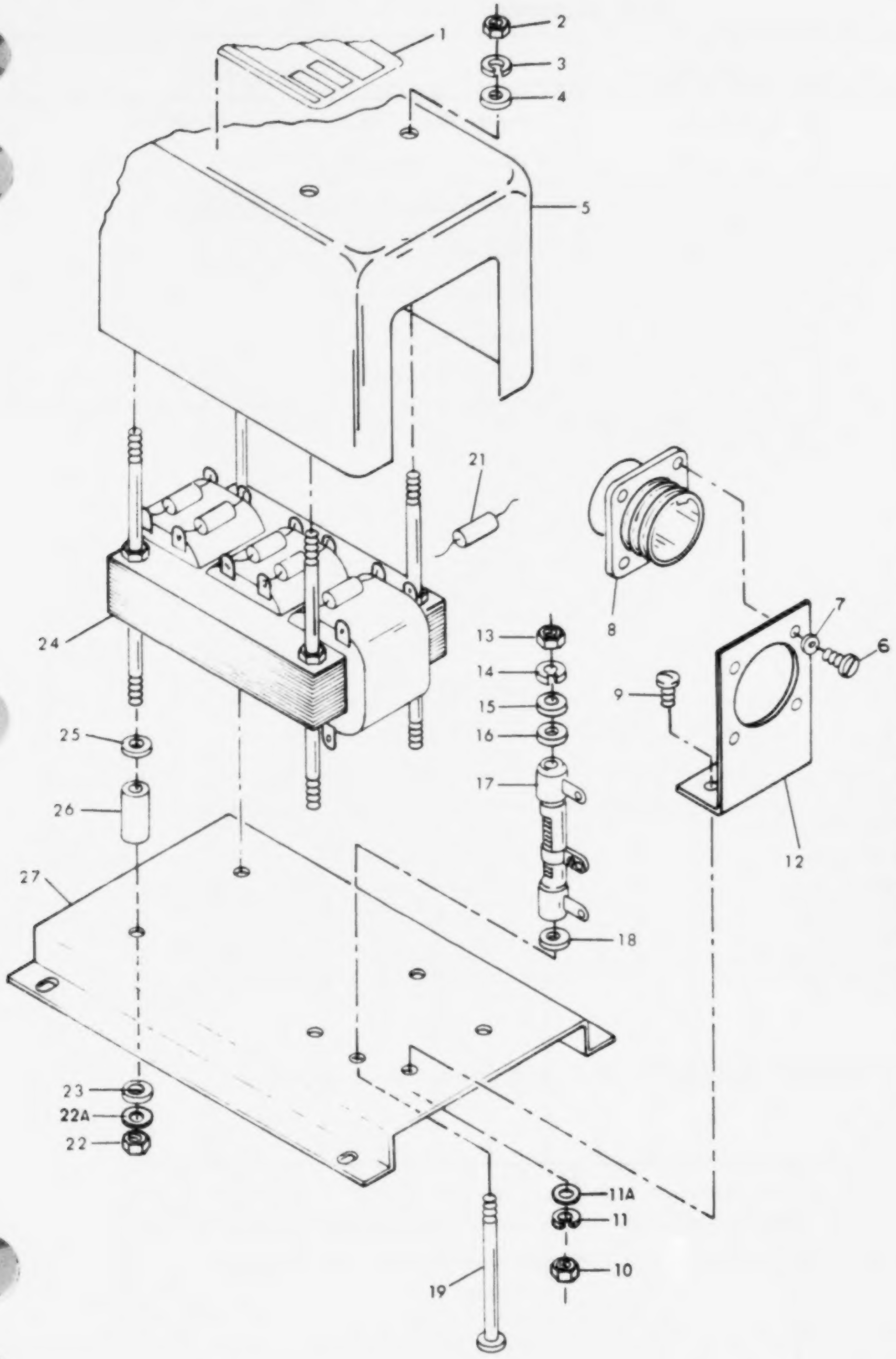
e. Replace a defective load measuring unit, if voltage relationships do not match the graph.

### 8-19. Repair, Reassembly and Installation.

a. Repair. Replace load measuring unit that does not meet testing requirements.

b. Reassembly. See figure 8-20 and reassemble the load measuring unit.

c. Installation. See figure 8-1 and install the load measuring unit (7) on relay table (52) with screws (5).



1
2
3
4
5
21
8
7
6
24
13
14
15
16
9
25
17
26
12
27
18
23
22A
22
11A
11
10
19

1. Nameplate
2. Nut
3. Washer
4. Washer
5. Cover
6. Screw
7. Washer
8. Harness assy
9. Screw
10. Nut
11. Washer
11A. Washer
12. Bracket
13. Nut
14. Washer
15. Washer
16. Washer
17. Resistor
18. Washer
19. Screw
20. (Deleted)
21. Diode
22. Nut
22A. Washer
23. Washer
24. Transformer assy
25. Washer
26. Sleeve
27. Bracket

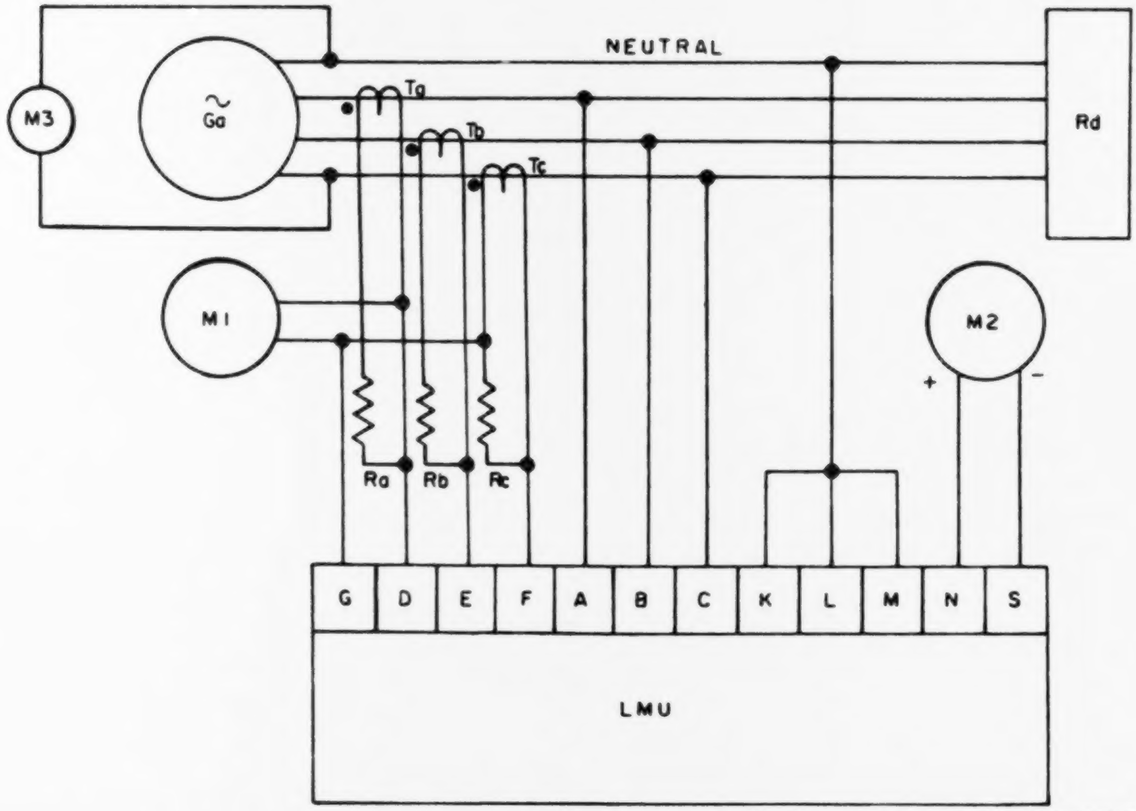
ME 6115-545-34/8-20 C1

Figure 8-20. Load Measuring Unit Disassembly

TEST EQUIPMENT

| REF DESIGNATION | QUANTITY | DESCRIPTION |
|---|---|---|
| Ga | 1 | Power source 208 V, 3 phase, 47-430 Hz |
| Ta, Tb, Tc | 3 | * Current transformers |
| Ra, Rb, Rc | 3 | Load resistors 7.5 ohms, 10 watts |
| Rd | 1 | Load bank |
| M1 | 1 | Voltmeter 0-10 Vac |
| M2 | 1 | Voltmeter 0-50 Vdc |
| M3 | 1 | Voltmeter 0-300 Vac |

* Shall be designed to deliver 0-5.6 volts as load is varied from zero to full load.


NEUTRAL
M3
Ga
Ta
Tb
Tc
Rd
M1
M2
+
-
Ra
Rb
Rc
G
D
E
F
A
B
C
K
L
M
N
S
LMU

ME 6115-545-34/8-21

Figure 8-21. Load Measuring Unit Test, Schematic Diagram

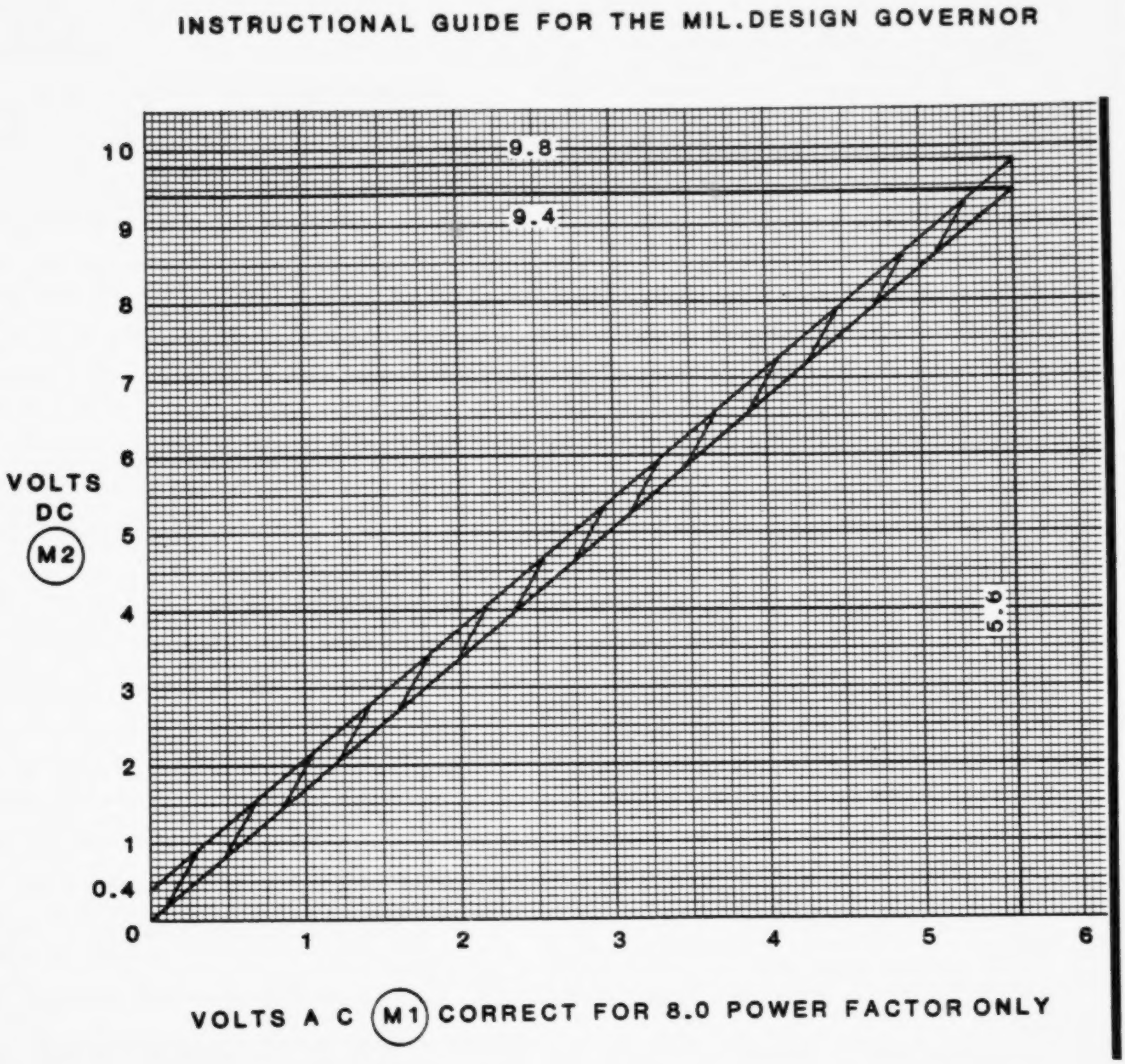
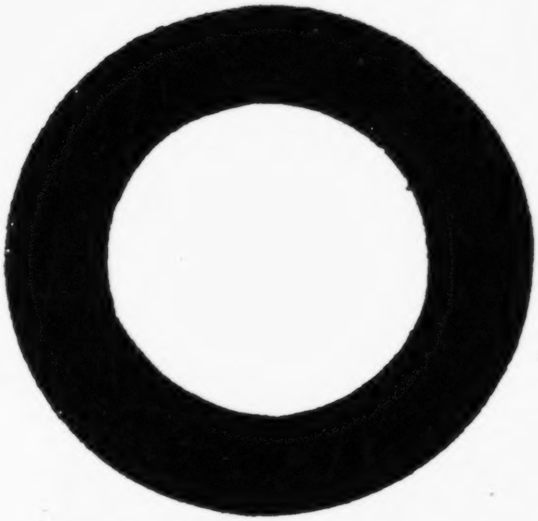


Figure 8-22. Load Measuring Unit Test, Voltage Relationship Graph



# CHAPTER 9

## GENERATOR ASSEMBLY REPAIR INSTRUCTIONS

### 9-1. General.

a. The main generator is a brushless type consisting of a stationary three-phase armature and a rotating salient pole wound field. The exciter, mounted integrally with the main generator, consists of a three-phase rotating armature mounted on the shaft with the generator field and a stationary salient pole field. The exciter has ten poles.

b. A full wave bridge rectifier containing six diodes is mounted on the shaft. Access to test or replace the rectifiers is through the access hole on the end of the endbell assembly. Access to the exciter stator and rotor, and inspection of the main generator armature and field, require disassembly of the generator.

c. The generator shaft is directly driven by the engine shaft through flexible metal disk coupling. The flexible coupling compensates for misalignment between the two shafts to eliminate injurious stress on the connecting components.

d. The main generator stator is installed in the stator frame and is fastened to and spaced by longitudinal ribs which are part of the frame. An eye bolt on the stator frame provides a means of lifting the unit. The exciter stator is mounted in an endbell which positions on the stator frame rabbit.

e. The rotor is supported at one end by a single bearing in an endbell bolted to the stator frame. The opposite end of the rotor is provided with a blower assembly and coupling disk which bolts directly to the engine flywheel. The rotor is skewed to improve generator output voltage waveform.

f. The bearing is a double-seal type ball bearing, packed with grease conforming to Specification MIL-G-23827. It provides a minimum of 5000 hours of service at continuous loads.

### 9-2. Generator Removal and Disassembly.

a. Insulation Resistance. To test insulation resistance, use a megohmmeter to measure the resistance between a winding and ground. The insulation resistance of each of the windings should be at least 1 megohm at 75°F. If this value is not met, clean or dry out the winding and repeat the test. Replace if defective.

NOTE

Low insulation resistance may be caused by dirt or excessive moisture. Insulation failure may be caused by wrong voltages, induced voltages caused by opening field circuits too quickly, oil and grease, high temperatures or excessive vibration.

(1) Generator Stator - Disconnect all leads to voltage regulator and all other points to completely isolate the winding before meggering.

(2) Generator Rotor - Disconnect both field leads from the rotating diode assembly before meggering.

(3) Exciter Stator - Disconnect both field leads from terminals 15 and 16 of TB16.

(4) Exciter Rotor - Check this only if other windings have low insulation resistance as the leads must be unsoldered from all diodes before meggering.

b. Electrical Malfunctions and Isolation. A malfunction of the main generator is usually indicated by low output voltage, or no voltage output. To isolate a malfunction to the main generator, proceed as follows:

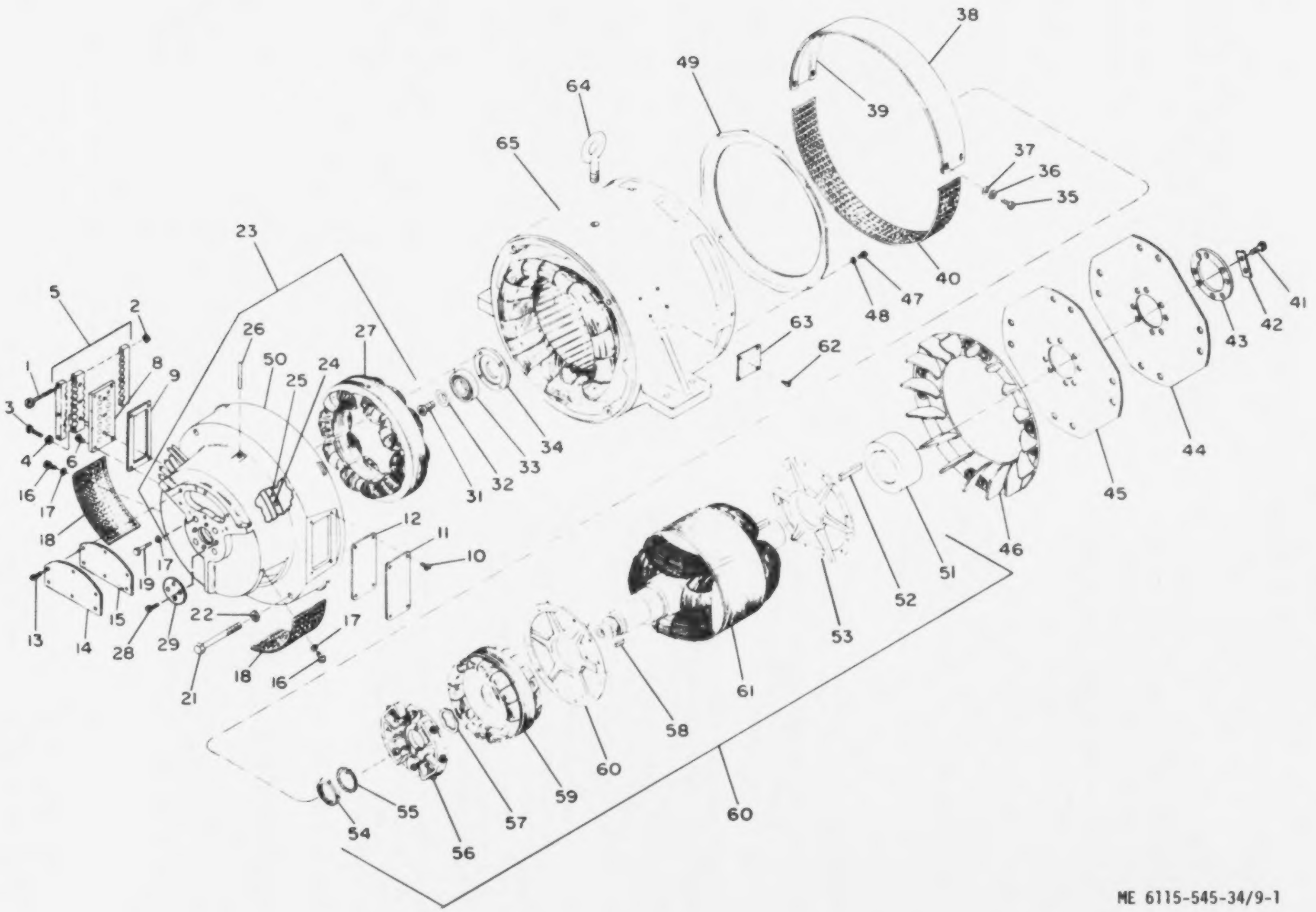
(1) Tag and disconnect the two top leads on terminals 15 and 16 of TB16 (located on the current transformer mounting plate). Connect one side of a dc ammeter to one of the terminals (15 or 16) and an adjustable dc voltage source to the other terminal and the dc ammeter. The adjustment should be set to minimum voltage.

(2) If the set is a 50/60 Hz set, select 60 Hz and start the engine. Bring the speed up to 1800 rpm manually and turn on the adjustable dc power supply. Adjust the dc voltage so that the output voltage (no load) reads 208 or 416 volts (depending on low or high voltage connection). The dc ammeter should read between 1.25 and 1.55 amperes to produce either 208 or 416 volts.

(3) If the set is a 400 Hz set, start the engine and bring it up to 2000 rpm. Turn on the adjustable dc power supply. Adjust the dc voltage so that the output voltage (no load) reads 208 or 416 volts, (depending on low or high voltage connection). The dc ammeter should read between 3.0 and 3.65 amperes to produce either 208 or 416 volts.

(4) If the dc ammeter indicates incorrect input exciter current to obtain rated voltage in steps (2) or (3) above, the generator has failed. Proceed with the following steps. If the output is as specified, the excitation system assembly has failed (refer to paragraph 8-1). The following steps are presented to enable isolation of the fault within the generator. Only steps (5), (6) and (7) would normally be done without some disassembly of the generator.

(5) Remove six bolts securing air intake grille and remove grille. Remove screws, cover plate, and gasket from generator endbell. See figure 9-1. Remove bolts from the six diodes on the exciter rotor frame, one at a time, replacing each diode after testing. Test diodes per paragraph 14-12b.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ME 6115-545-34/9-1

Figure 9-1. AC Generator Assembly

Key to fig. 9-1.

1. Screw
2. Nut
3. Screw
4. Washer
5. Clamp assy
6. Screw
7. Screw
8. Plate
9. Gasket
10. Screw
11. Cover
12. Gasket
13. Screw
14. Cover
15. Gasket
16. Screw
17. Washer
18. Screen
19. Screw
20. Washer
21. Screw
22. Washer
23. Exciter assy
24. Screw
25. Clamp
26. Pin
27. Stator
28. Screw
29. Plate
30. Shield
31. Screw
32. Retainer
33. Bearing
34. Cap
35. Screw
36. Washer
37. Washer
38. Cover
39. Gasket
40. Screen
41. Screw
42. Strip
43. Ring
44. Disc
45. Disc
46. Fan
47. Screw
48. Washer
49. Deflector
50. Rotor assy
51. Hub
52. Key
53. Plate
54. Nut
55. Washer
56. Rectifier assy
57. Washer
58. Key
59. Rotor
60. Plate
61. Rotor
62. Screw
63. Plate
64. Eyebolt
65. Frame and stator assy

If any defective diodes are replaced, repeat step (2) or (3) above to determine if the generator defect has been corrected.

(6) Tag and disconnect the two top leads at pins 15 and 16 of TB16 (located on the current transformer mount plate). Read the exciter field resistance at pins 15 and 16 with a Wheatstone bridge. The exciter field resistance should be between 2.90 and 3.55 ohms at an ambient temperature of 65°F.

(7) Check insulation resistance with megger between pins 15 and 16 and the frame (para 9-2a). Reconnect the two leads and remove tags. Before proceeding further with fault isolation, disassemble the endbell from the generator.

(8) Disconnect generator rotor leads from the rotating diode assembly and measure the field resistance with a Wheatstone bridge. The resistance value for a 50/60 Hz generator should be 0.38 to 0.46 ohms and 1.17 to 1.43 ohms for a 400 Hz generator at an ambient temperature of 65°F.

(9) Megger between field leads and frame (para 9-2a).

(10) Disconnect diodes and use a double Kelvin bridge to read the resistance between leads on the exciter rotor. On a 400 Hz set, this value is 0.042 to 0.051 ohm and on a 50/60 Hz set, this value is 0.019 to 0.023 ohm at a 65°F ambient temperature.

(11) Check insulation resistance with megger between exciter armature leads and frame (para 9-2a).

(12) Check resistance of surge protector (varistor) when disconnected from one side of generator field. Value should be 1 megohm or more in each direction. Check to be sure no physical damage is evident on the surge protector.

(13) Tag and disconnect the twelve stator leads at the voltage reconnection panel and measure each of the six stator windings with a Kelvin double bridge. On a 50/60 Hz generator, the resistance should be 0.0216 to 0.0264 ohm in each circuit. On a 400 Hz set, the resistance value should be 0.0141 to 0.0173 ohm in each circuit, at ambient temperature of 65° F.

(14) Connect all stator leads together and read between the leads and the generator frame with a megger (para 9-2a).

(15) Growler test

(a) Perform internal growler test on stator by applying 110 Vac to the coil which is wound on the cross bar of the H.

(b) Place the growler on the coil of the stator so that it is in direct contact with two adjacent slots.

(c) A shorted coil produces a very heavy current which is indicated by the rapid vibration of a thin piece of metal, such as a hacksaw blade, held over the other end of the coil.

(d) Perform a growler test on the rotor as described in (a) above.

(e) Place the rotor on the growler and energize.

(f) Hold a thin piece of metal, such as a hacksaw blade, directly over the top slot of the rotor and along the length of the slot. If the coil is shorted, the blade will vibrate rapidly and cause a growling noise.

(16) If the above test values are not within the limits specified, proceed with the removal and repair procedures.

c. Defective Bearing Replacement. If a defective bearing is indicated by vibration or noise at the bearing housing on the endbell, the bearing can be replaced without removal of the generator from the set.

d. Removal of Bearing with Generator Installed.

(1) Disconnect the positive battery cable.

(2) Remove paralleling receptacle panel.

(a) Disconnect the paralleling receptacles.

(b) Tag each receptacle for proper location.

(3) Remove manual speed control panel.

(a) Disconnect flexible cable from manual speed control knob.

(b) Disconnect electrical connector from the Remote Control Box.

(4) Generator rear grille and access doors are now detached and may be removed.

(5) Remove transformer protective cover.

(6) Remove the load terminal board (TB6).

(7) Sequentially remove and tag each of the twelve generator leads on the rear of the load terminal board.

(8) Sequentially route the generator output leads back to the generator through their respective current transformers. (See fig. 6-2)

(9) Disconnect the exciter field leads from TB16 posts 15 and 16 and route the leads back to the generator.

(10) For removal of bearing, refer to f steps (1) through (4) inclusive.

(11) Reassemble in reverse order of disassembly.

e. Removal. Refer to paragraph 2-12 to remove main generator.

f. Disassembly. See figure 9-1 and disassemble in the order of sequence numbers observing the following.

(1) Break endbell fit by tapping on knock off lugs located in the 45 degree positions. Slide endbell axially off the bearing. Pass stator leads through endbell opening as endbell is removed from the stator.

(2) The exciter stator may be removed from the endbell assembly by removing or drilling out the dowel pin (26). Only a small force is needed to remove the stator.

(3) Remove screw with an Allen wrench and then remove bearing retainer.

(4) Pull the bearing (33) with a suitable bearing puller and replace with new bearing.

(5) To remove the rotating diode assembly, bend up the lock tab on lockwasher and unscrew the locknut.

(6) Unscrew the generator field leads from the plate (8), (fig. 9-2) and unsolder the six exciter leads from the diodes. These leads should be tagged to maintain the polarity of the diodes when reassembled.

CAUTION

Use a soldering iron no larger than 100 watts and as little time and force as possible to unsolder the leads. The diodes can be damaged by excess heat or force sufficient to bend the stem or break the glass seal.

(7) The surge protector may be removed from the rotating diode assembly.

(8) After the leads are disconnected, the rectifier assembly (fig. 9-2), key and spring washer will slide off the shaft.

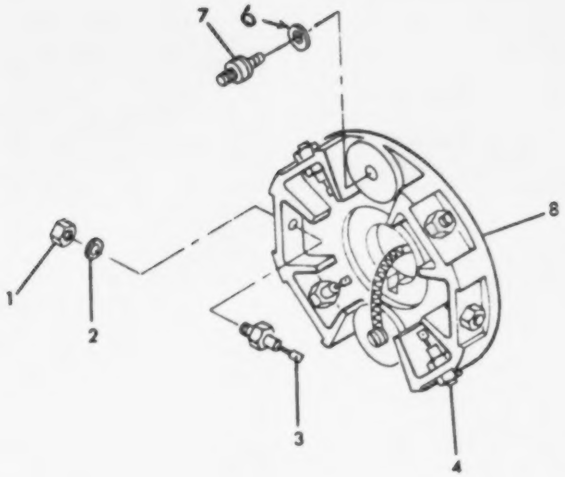
(9) To remove the rotor assembly from the stator proceed as follows: Slide the rotor through the stator toward the drive end far enough so that a sling may be placed under the generator field core. Hoist the rotor slightly to free it. Pull the rotor axially while applying leverage at the drive end to balance the rotor on the sling. It may take one or two repositionings of the sling to get the sling near the center of the rotor core for proper balancing of the assembly.

(10) The exciter rotor may be removed from the shaft by using a bearing puller near the outside diameter. Be careful not to bear on windings if exciter rotor is to be reused.

(11) Balance plates are shrunk on the shaft and may be removed with heat. Apply heat with a torch to the hub of the balance plate. Move the torch around the periphery of the hub using care not to apply the torch to the shaft. The balance plate bore will expand and the balance plate may be removed manually.

(12) The coupling hub is shrunk fit on the shaft. To remove, use a cutting torch to cut through the hub at the keyway to prevent shaft damage. After cutting through, use a chisel in the cut to open the bore and remove the hub.

(13) The generator stator core is not to be removed from the stator frame because the concentricity between bore and rabbit fits would be disturbed and cause voltage modulation problems. When removing the rotor stack from the shaft, remove in the direction, that the stack was pressed on.



1. Nut
2. Washer
3. Rectifier
4. Rectifier
5. (Deleted)
6. Washer
7. Surge protector
8. Plate

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Figure 9-2. Rectifier Assembly

9-3. Generator Cleaning and Inspection.

a. Cleaning. Clean all metal parts with Federal Specification P-D-680 and dry thoroughly. Use a clean cloth to clean the stator frame. Use low pressure compressed air (10 to 15 pounds pressure) to remove dust and dirt from inside the frame and core, and from the rotor windings.

b. Inspection. Proceed as follows:

(1) Inspect stator frame for cracks and burred mating surfaces.

(2) Inspect rotor and stator of generator and exciter for loose, frayed, or burned windings.

(3) Inspect coupling disks and fan for distortion and excessive wear.

(4) Inspect for missing or defective hardware.

(5) Inspect rotating diode assembly for broken diode cases. Test diodes per paragraph 14-10.

9-4. Generator Repair and Rebuild.

a. Generator Repair. Proceed as follows:

(1) Replace or rebuild all defective parts (refer to paragraph 9-2d for disassembly information.) To remove coils from an iron core, it is recommended that the part be heated in a moderate oven temperature (150° C) to facilitate removal. Single coils should not be replaced as adjacent parts of the winding may be damaged during coil removal.

(2) Apply varnish to any damaged areas of insulation.

(3) Replace damaged exciter rotor or stator.

b. Generator Rebuilding (50/60 Hz). Proceed as follows:

(1) Stator winding procedures.

(a) Single wires may be spliced by brazing. The splice is to be insulated by sliding sleeving over the wire prior to brazing and relocating the sleeving over the splice after completion. The sleeving is to extend a minimum of 1/2-inch beyond the bare uninsulated portion of wire. The sleeving material is to be the same as that used for cross-overs on the connection end. Splices shall be made in the end turn of the coil only and shall not be made in the straight leg. Where more than one splice is required, the second splice must not occur on the same coil end and must not occur in adjacent coils. Where more than one splice is necessary in the same coil or an adjacent coil, the splice may be made in the connection end of the coil.

(b) Enamel is to be cleaned from coil extensions. Cleaning is to start as near sleeving as possible. Clean a 1/2-inch section of wire end projecting from a sleeving. Maximum uncleaned wire projecting from a sleeving section shall be 3 inches minimum to 5 inches maximum. Wire diameter is to be reduced a maximum of 5 percent. Cleaned area shall have enamel removed over 80 percent of the surface.

(c) Slot tubes should be inserted with overhang equally divided on ends. Minimum slot tube overhang (distance from core to end of slot tube) shall be 1/4 inch. Position of the tubes should be adjusted so that height of sides is equal. (fig. 9-3)

(d) After the slot tubes have been inserted, insulating tape shall be placed into the stator to form a bridge between slot tubes. It will be placed so as to bridge every other tooth in the stator core in one continuous length by stringing it through one slot, crossing over at the end of the slot to the next slot, back through and on to the third slot, continuing until it is back at the starting point. The starting and finish ends shall be securely tied together. This bridge is to restrain the end turn tie cord.

(e) Coils shall be inserted in slots so that overhanging ends are equally spaced. Wire bundles at entrance to slot should be brought out as straight and compactly as possible to reduce side pull on overhanging slot tube ends.

(f) Care should be taken to see that wire insulation is not scratched or otherwise damaged. Coil wires should not be kinked or crossed in the slots. Tools inserted into slots to adjust position of wires or separators should be free from burrs or sharp edges to prevent damage to wire or slot insulation. If it is necessary to use a mallet when tamping down wires or separators in slots, tap the slot tools lightly. Heavy pounding will ruin the insulation.

(g) After bottom coil sides are in the slots, the separators are wedged in place with their overhanging ends equally spaced. These ends should project approximately 1-1/2 inches from edge of core. The separators should fit tightly enough to hold the coils down in the slots.

(h) Phase insulating strips are placed in the end turns to insulate between the coil groups on both ends of the winding. These strips should be placed so that the back edge reaches the ends of the wedges approximately 1/2 inch from core. The strips will then overlap the ends of the separators. After coil ends are properly shaped, trim phase insulating strips all around so that 1/16 to 1/4 inch of edge projects beyond edge of wires. Phase insulating strips may extend 1/2 inch beyond wire on coil outer diameters.

(i) Top sticks shall be carefully inserted so that slot tubes and wire are not damaged. The overhanging ends should be equal and they should be level. Top sticks which are broken or split during insertion should be replaced.

(j) Connections shall be twisted together and brazed using brazing alloy. The distance from the first twist to the film coating on the wire must not exceed 1-1/2 inches. End of connection forming pigtail shall be fusion welded as much as possible with addition of alloy. When coil pole leads and ends consist of multiple wires, care must be taken to insure that each wire is securely connected. All sharp wire ends or spikes of solder remaining on brazed joints should be trimmed off or flattened down to prevent puncturing of insulation tape.

(k) When connectors are used instead of brazing connections, wire must extend completely through the connector. The connector should be located as close to the insulated portion of the wire as is possible. Connectors must be applied using a wire crimping tool -- crimping is not to be done using pliers, hammers or other make-shift arrangements.

(l) Sleeving must be positioned to cover the coil extension from the coil to which it is attached to a point at least 1/2 inch under two layers of tape. The sleeving at the coil end must be positioned to provide a minimum of 3/8-inch creepage path from the coil extension to adjacent coils.

(m) All connections in stator winding shall be covered with sleeving, MIL-I-3190/3. Where tape is wide enough to cover the uninsulated wire and extend a minimum of 1/2 inch over insulated portion of wire, wrap one layer of tape over the connection, pressing the two adhesive sides together for approximately 1/4 inch. The remaining length of tape should be long enough to make two or more wraps over the connection. The connection and any uninsulated part of the wires adjacent to the connection will be covered with three thicknesses of tape.

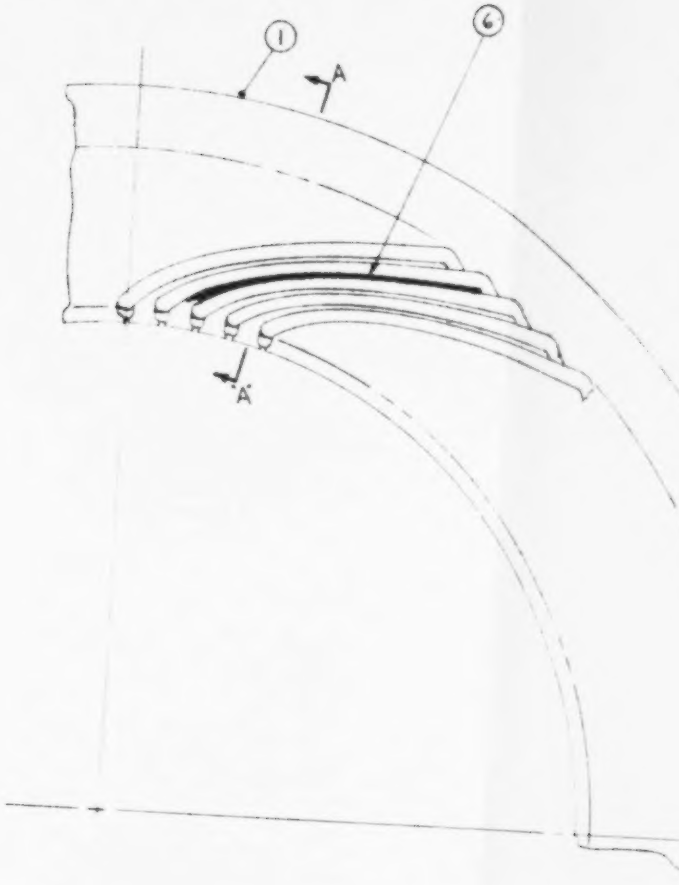
(n) Where the tape is not wide enough to provide coverage for the connection, the tape shall be wrapped around the connection such as to provide 1/2-inch lap plus 1/8 inch (minimum). The overlap is to be such as to provide a minimum of two layers of tape. The double layer of tape is to extend a minimum of 1/2 inch over the insulated portion of wire.

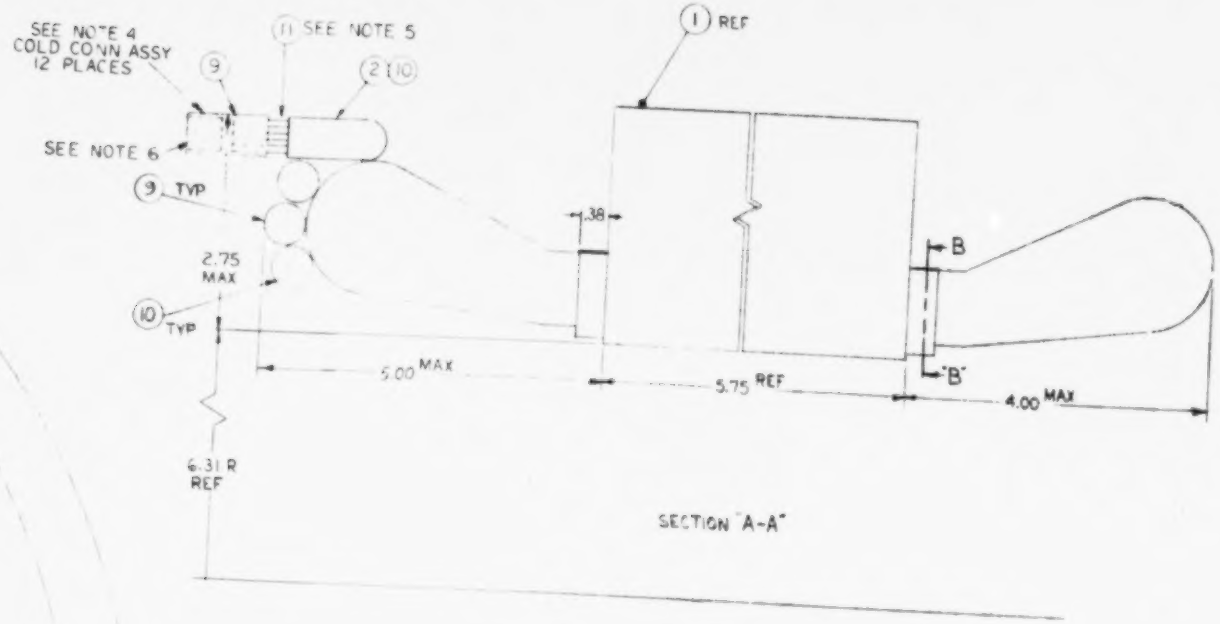
(o) Stator windings will be tied on lead end only. Use a hitch or chain stitch tie. Spacing between ties is not to exceed 3 inches. A tie must be made over each connection. Tie on either side of cable bundle will be a double lace. Tie must pass through space between coils bridged by tape specified under tie cord bracing ((d) above).

(p) End turns on opposite lead side will not be tied. However, the string ties, placed on the individual coils during coil winding operation, will be left on untaped coil after insertion, to help keep wires from being displaced.

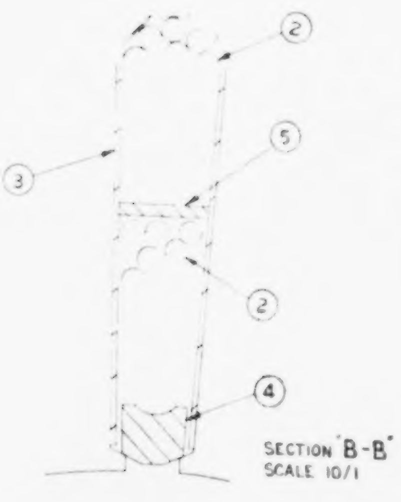
(q) Refer to table 9-1 for winding data.

(2) Stator dip and bake (50/60 Hz).




SEE NOTE 4
COLD CONN ASSY
12 PLACES
9
11 SEE NOTE 5
2 10
1 REF
SEE NOTE 6
9 TYP
2.75 MAX
10 TYP
.38
B
B
5.00 MAX
5.75 REF
4.00 MAX
6.31 R REF
SECTION "A-A"

| | | |
|---|---|---|
| 14 | AR | VARNISH |
| 13 | AR | VARNISH |
| 12 | AR | ROVING |
| 11 | AR | TAPE |
| 10 | AR | SLEEVING, |
| 9 | 12 | CONNECTOR |
| | | |
| | | |
| 6 | 24 | PHASE INSULATION |
| 5 | 84 | PHASE INSULATION |
| 4 | 84 | TOP STICK |
| 3 | 84 | SLOT INSULATION |
| 2 | AR | WIRE MAGNET, AWG #15 |
| 1 | 1 | WELDED CORE ASS'Y |
| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION |
| LIST OF MATERIAL | | |


2
5
3
2
4
SECTION "B-B"
SCALE 10/1

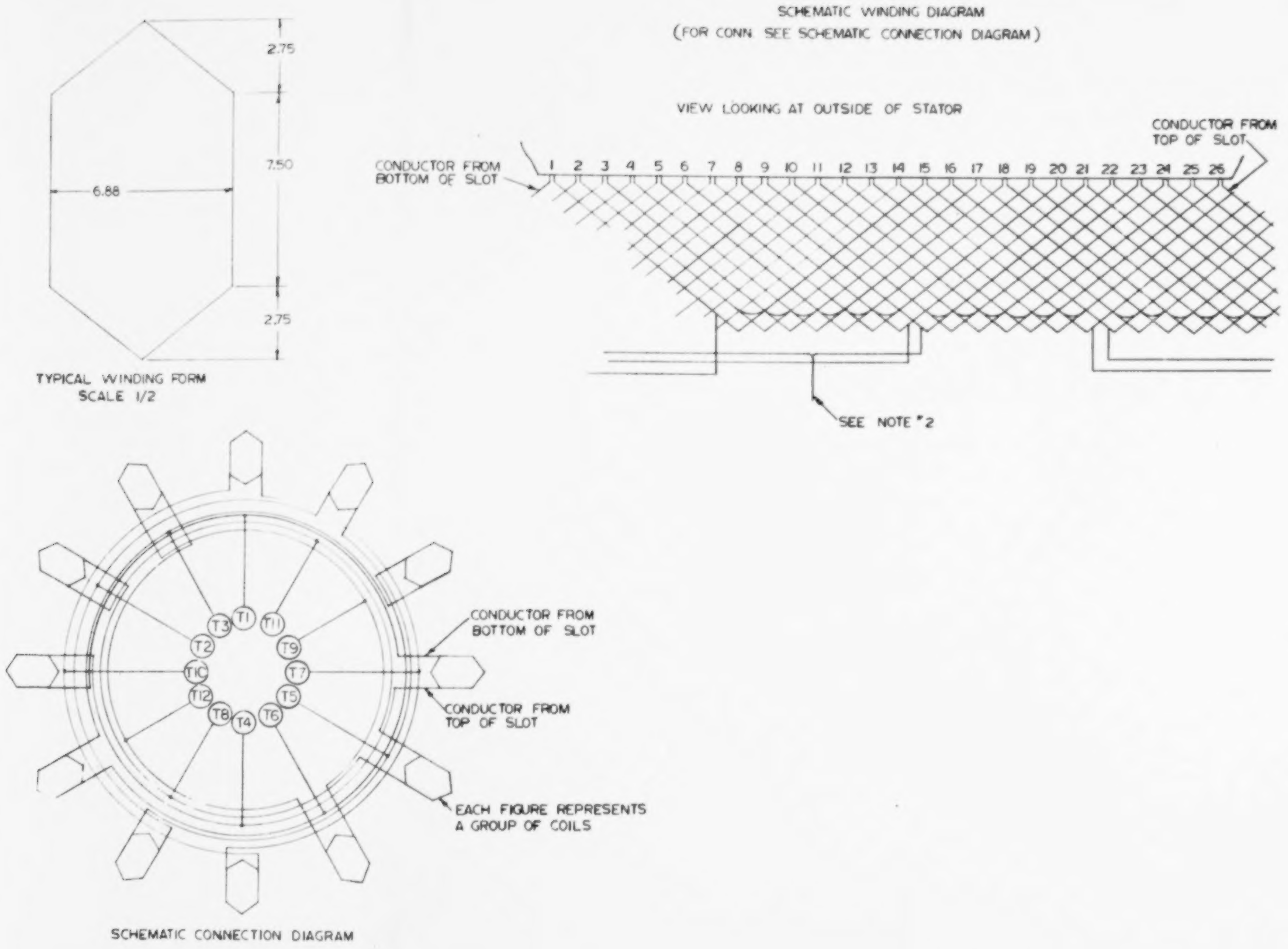
| WINDING DATA | |
|---|---|
| TYPE OF WINDING | 3 PHASE, DUAL VOLTAGE |
| NO. OF SLOTS AND COILS | 84 SLOTS 84 COILS |
| NO. OF COILS PER GROUP | 7 |
| TURNS PER COIL | 4 |
| SPAN | 1-15 |
| CONDUCTOR | 6 OF AWG #15 (.0571 DIA) |
| CONNECTION | 4-2 CKT, SEE SCHEMATIC DIAGRAM |
| RESISTANCE (1-4, 2-5, ETC) | 0215 - .0263 OHMS AT 25° C. |

NOTES

1. INTERPRET DWG PER MIL-STD-100.
2. ASSEMBLY - ASSEMBLE FIND NO. 10 OVER COILS PRIOR TO INSERTION. ASSEMBLE COILS AND INSULATION IN ACCORDANCE WITH THIS DRAWING. COLD CONNECT FIND NO. 2 USING FIND NO. 9. TAPE JOINTS WITH 3 LAYERS OF FIND NO. 11. EXTEND FIND NO. 11 TO COVER A MINIMUM OF .50 INCH EITHER SIDE OF JOINT. ALL CONNECTIONS TO BE SECURELY LACED TO END TURNS USING FIND NO. 12.
3. INSULATION TREATMENT -
   STEP 1 - DIP CORE HEATED TO 105°C TO 115°C INTO FIND NO. 13 FOR 3 MINUTES. DRAIN FOR 4 MINUTES AND BAKE FOR 2 HOURS AT 170°C.
   STEP 2 - DIP CORE HEATED TO 170°C INTO FIND NO. 14 FOR 3 MINUTES. DRAIN FOR 4 MINUTES AND BAKE FOR 2.5 HOURS AT 170°C. REPEAT STEP 2 TWO MORE TIMES FOR A TOTAL OF 3 DIPS AND BAKES OF STEP 2.
4. CONNECTOR TO BE USED WITH AMP TOOLING.
5. USE FIND NO. 11 ONE LAYER AND OVERLAP FIND NOS. 9 AND 10 .50 INCH.
6. INSIDE OF FIND NO. 9 SHOULD BE KEPT FREE OF VARNISH.

ME 6115-545-34/9-3(1) C4

Figure 9-3. Stator Winding and Coil Connection (50/60 Hz) (Sheet 1 of 2)


2.75
7.50
6.88
2.75
SCHEMATIC WINDING DIAGRAM
(FOR CONN. SEE SCHEMATIC CONNECTION DIAGRAM)
VIEW LOOKING AT OUTSIDE OF STATOR
CONDUCTOR FROM TOP OF SLOT
CONDUCTOR FROM BOTTOM OF SLOT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
SEE NOTE #2
T1
T3
T11
T2
T9
T10
T7
T12
T5
T8
T4
T6
CONDUCTOR FROM BOTTOM OF SLOT
CONDUCTOR FROM TOP OF SLOT
EACH FIGURE REPRESENTS A GROUP OF COILS

TYPICAL WINDING FORM
SCALE 1/2

SCHEMATIC CONNECTION DIAGRAM

ME 6115-545-34/9-3(2) C1

Figure 9-3. Stator Winding and Coil Connection
(50/60 Hz) (Sheet 2 of 2)

Table 9-1. Stator Winding Data (50/60 Hz)

| | |
|---|---|
| Type of winding | 3 phase, dual voltage |
| No. of slots and coils | 84 slots 84 coils |
| No. of coils per group | 7 |
| Turns per coil | 4 |
| Span | 1-15 |
| Conductor | 6 of AWG #15 (0.0571 dia) |
| Connection | 4.2 ckt, (See fig. 9-3) |
| Resistance | 0.026 ohm at 25° (T1-T4, etc.) |

(a) Preheat wound core for 1 1/2 hours (2 hours maximum) in forced convection oven maintained at 170° C.

(b) Cool core down to a temperature of 105° to 115° C and dip at this temperature into varnish, connection end up, until all bubbling stops, or for 3 minutes, whichever is longer.

(c) Remove wound core and drain connection end up for four minutes.

(d) Rotate wound core so connection end is down and drain for one minute.

(e) Bake wound core with slots in horizontal position for 2 hours in forced convection oven maintained at 170° C.

(f) Repeat steps b, c, d, e and f two times so that a total of three dips and bakes are performed.

(g) The wound stator should be examined for complete coverage, uniform coverage with no strings or beads and with openings between extended position of slot tubes, free of varnish, blistering or peeling, and complete cure with tack-free surface and good bonding strength.

(3) Rotor coil winding.

(a) Inspect winding slots for any sharp corners at edge and in slot. Clean up as necessary.

(b) Screw support studs into tapped holes at bottom on slots. See figure 9-4.

(c) Examine the bore and determine the direction in which it was removed. Place the leads on the end where the shaft left the bore. This is so the shaft can be pressed thru the bore in the direction it was removed. The center of the rotor stack must be located 11.48 inches from the hub end of the shaft.

(d) Insert slot liners as the poles are wound. Hold in place with sacrifice adhesive tape.

(e) With the rotor body turning on the machine, guide the wire into the slots for the specified number of turns. Hold the wire with enough tension on the tension blocks to assure a hard firm winding. Traverse the wire at the end turns and not in the slot, as much as possible. This prevents excessive build up of the wire in the slot.

(f) Place one spacer tool at the end of stack and another in the approximate middle of the winding.

(g) Place winding clamp in position over stud and force into position so that nut can be tightened over end of stud.

(h) Connect poles and leads per connection diagram. See figure 9-4. Use cold connectors and insulate with tubing.

(i) Tie the end turns with glass roving.

(j) Seal all knots by momentarily pressing with "hot" pliers long enough to fuse the roving. Heat pliers in gas flame to "Black Heat" about 300° F.

(k) Refer to table 9-2 for winding data.

(4) Rotor dip and bake.

(a) Preback wound core for one hour in forced convection oven at 165° C.

(b) Dip hot wound core in varnish for one minute with leads up.

(c) Remove wound core and drain for three minutes with leads up.

(d) Rotate wound core with leads down and drain for one minute.

Table 9-2. Rotor Winding Data (50/60 Hz)

| | |
|---|---|
| Resistance | 0.390 ohms at 25° C |
| Connection | 1 circuit (refer to fig. 9-4) |
| Conductor | 9 of AWG #16 (0.0508) |
| Turns per coil | 103 |
| No. of poles and coils | 4 |

(e) Reverse wound core so leads are horizontal and bake for one hour in forced convection over at 165° C.

(f) Repeat steps b, c, d, and e two times so that a total of three dips and takes are performed.

(g) The varnished wound rotor core should be examined for complete coverage, uniform coverage with no strings or beads and with openings between extended position of slot tubes free of varnish, blistering or peeling, and complete cure, with tack-free surface and good bonding strength.

c. Generator Rebuilding (400 Hz). Proceed as follows:

(1) Stator coil winding procedures. See figure 9-5 and table 9-3, and perform the procedures provided in step b (1).

(2) Stator dip and bake. Perform the procedure defined in step b (2).

(3) Rotor coil winding.

(a) Inspect winding slots for any sharp corners at edge and in slot. Clean up as necessary.

(b) Examine bore and determine the direction in which the broach passed through the bore. Place the leads on the end where the broach left the bore. This is so the shaft will be pressed through the bore in the same direction as the broach.

(c) Insert slot liners (3) in the slots and position with equal overhang of the core on each end. See figure 9-6.

(d) Insert the coils in the usual manner. Position the coils as evenly as possible on each end. Consult the coil limit diagram to be sure that the two ends are adjusted to allow room for the connections, which must be within the coil limit diagram.

(e) Insert tapered edge top stick and drive into position.

(f) Make interpole and lead connections as required by internal connection diagram. See figure 9-6.

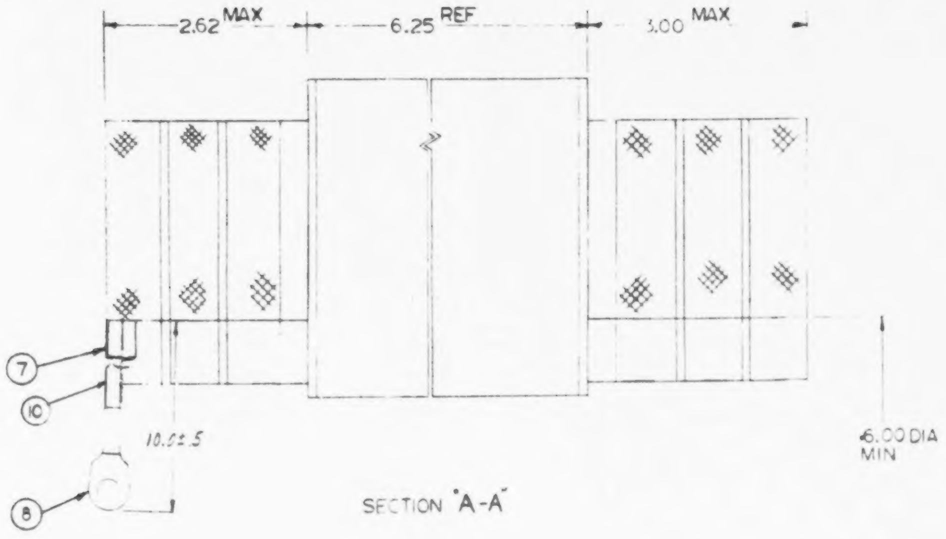
(g) Over each end, turn-wrap 20 turns of double glass roving to provide banding support of end turns.

(h) With double roving, loop over the banding and connections and run one continuous piece of double roving over all 24 coil ends. Burn all knots with red hot duck bill pliers.

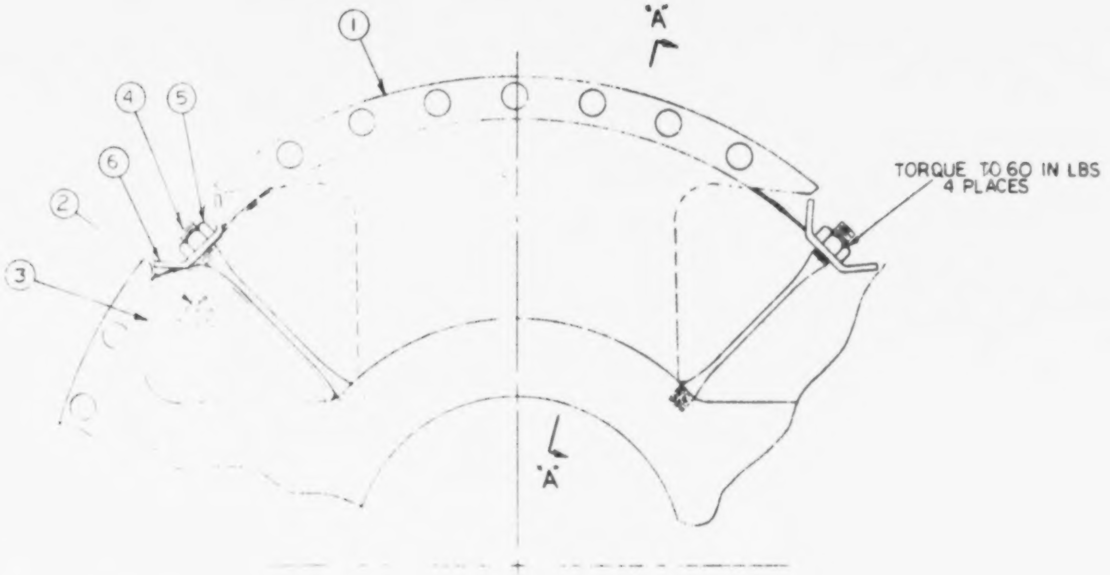
(i) Refer to table 9-4 for 400 Hz rotor winding data.

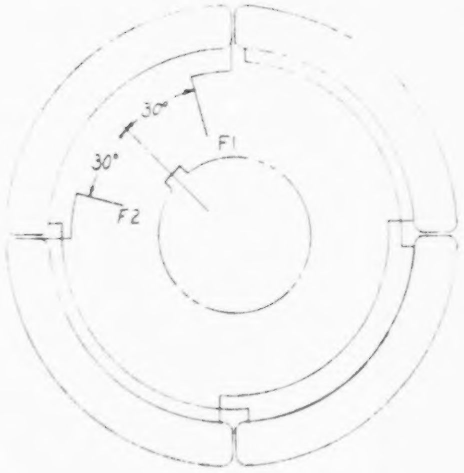
Table 9-3. Stator Winding Data (400 Hz)

| | |
|---|---|
| Type of winding | 3 phase, dual voltage |
| No. of slots and coils | 108 slots 108 coils |
| No. of coils per group | 36 groups of 2 and 36 groups of 1 |
| Turns per coil | 5 |
| Span | 1-4 |
| Conductor | AWG #16 (0.0508) and AWG #17 (0.0453) |
| Connection | 12/6 ckt, (see fig. 9-5) |
| Resistance | 0.017 ohm at 25° C (T1-T4, etc.) |



SECTION "A-A"





SCHEMATIC DIAGRAM

| | |
|---|---|
| RESISTANCE | .382-.466 OHMS AT 25° C |
| CONNECTION | 1 CIRCUIT SEE SCHEMATIC DIAGRAM |
| CONDUCTOR | 9 OF AWG #16 (.0508) |
| TURNS PER COIL | 103 |
| NO OF POLES AND COILS | 4 |

WINDING DATA

| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION |
|---|---|---|
| 14 | AR | VARNISH |
| 13 | AR | VARNISH |
| 12 | | |
| 11 | AR | ROVING |
| 10 | AR | SLEEVING |
| 9 | 2 | CONNECTOR |
| 8 | 2 | TERMINAL |
| 7 | AR | WIRE |
| 6 | 8 | WINDING CLAMP |
| 5 | 8 | NUT |
| 4 | 8 | STUD |
| 3 | 8 | SLOT INSULATION ASSY |
| 2 | AR | WIRE MAGNET AWG #16 (.0508) |
| 1 | 1 | ROTOR CORE WELDED |

LIST OF MATERIAL

NOTES

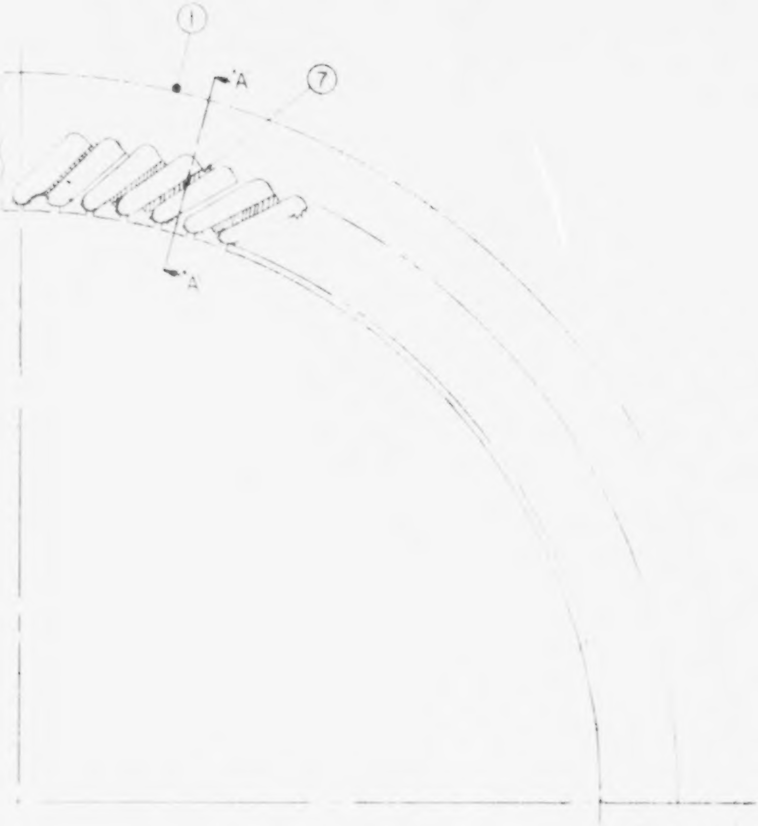
1. INTERPRET DWG PER MIL-STD-100
2. ASSEMBLY - ASSEMBLE COILS IN ACCORDANCE WITH THIS DRAWING. COLD CONNECT FIND NO. 7 TO COIL LEADS USING FIND NO. 9. USE FIND NO. 10 OVER CONNECTORS. EXTEND FIND NO. 10 A MINIMUM OF .50 INCH EITHER SIDE OF CONN. ALL CONNECTIONS TO BE SECURELY LACED TO END TURNS USING FIND NO. 11.
3. INSULATION TREATMENT

   STEP 1 - DIP CORE HEATED TO 160°C INTO FIND NO. 13 FOR 3 MINUTES. DRAIN FOR 10 MINUTES AND BAKE AT 160°C FOR 3 HOURS. REPEAT STEP 1 FOR A TOTAL OF 2 DIPS AND BAKES.

   STEP 2 - DIP CORE HEATED TO 170°C INTO FIND NO. 14 FOR 3 MINUTES. DRAIN FOR 4 MINUTES AND BAKE AT 170°C FOR 2.5 HOURS. REPEAT STEP 2 TWO MORE TIMES FOR A TOTAL OF 3 DIPS AND BAKES OF STEP 2.

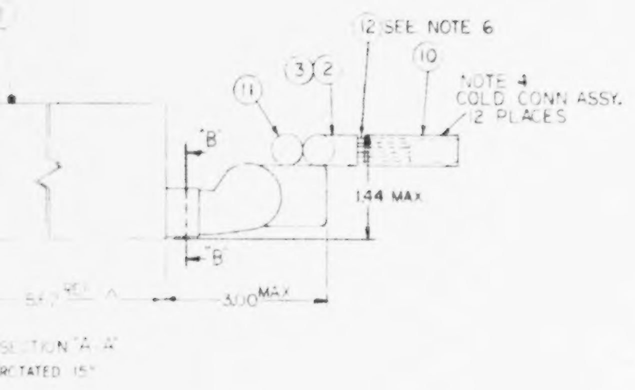
ME 6115-545-34/9-4 C4

**Figure 9-4. Rotor Winding and Coil Connection (50/60 Hz)**



.44
1.44 MAX
.150 MAX
7.63 R REF
②
⑥
④

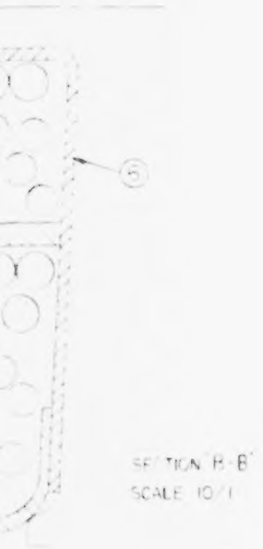
| WINDING DATA | |
|---|---|
| TYPE OF WINDING | 3 PHASE, DUAL VOLTAGE |
| NO OF SLOTS AND COILS | 108 SLOTS 108 COILS |
| NO OF COILS PER GROUP | 36 GROUPS OF 2 & 36 GROUPS OF 1 |
| TURNS PER COIL | 5 |
| SPAN | 1-4 |
| CONDUCTOR | AWG #16 (.0508) AND AWG #17 (.0453) |
| CONNECTION | 12/6 CKT. (SEE SCHEMATIC DIAGRAM) |
| RESISTANCE 1-4, 2-5 ETC | .0135-.0165 OHMS AT 25° C |



SECTION 'A-A'
ROTATED 15°

| FIND NO. | QTY REQD | NOMENCLATURE OR DESCRIPTION |
|---|---|---|
| 16 | AR | VARNISH |
| 15 | AR | VARNISH |
| 14 | AR | BRAZING ALLOY |
| 13 | AR | ROVING |
| 12 | AR | TAPE |
| 11 | AR | SLEEVING |
| 10 | 12 | CONNECTOR |
| | | |
| | | |
| 7 | 144 | PHASE INSULTION |
| 6 | 108 | SLOT INSULATION |
| 5 | 108 | PHASE INSULATION |
| 4 | 108 | TOP STICK |
| 3 | AR | WIRE, MAGNET, AWG #17 (.0453) |
| 2 | AR | WIRE, MAGNET, AWG #16 (.0508) |
| 1 | 1 | WELDED CORE ASS'Y |

LIST OF MATERIAL



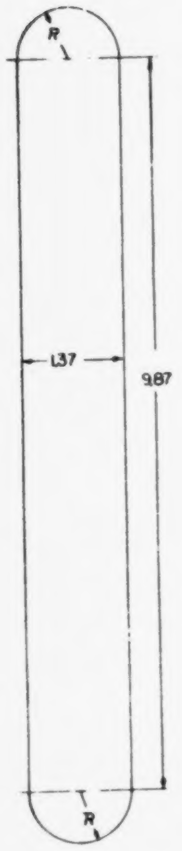
SECTION 'B-B'
SCALE 10/1

NOTES

1. INTERPRET DWG PER MIL-STD-100
2. ASSEMBLY - ASSEMBLE FIND NO. 11 OVER COIL LEADS PRIOR TO INSERTION. ASSEMBLE COILS AND INSULATION IN ACCORDANCE WITH THIS DRAWING. COLD CONNECT FIND NO. 2 AND 3 USING FIND NO. 10. ALL OTHER CONNECTIONS BRAZE USING FIND NO. 14. TAPE JOINTS WITH 3 LAYERS OF FIND NO. 12. EXTEND FIND NO. 12 TO COVER A MINIMUM OF .50 INCH EITHER SIDE OF JOINT. ALL CONNECTIONS TO BE SECURELY LACED TO END TURNS WITH FIND NO. 13.
3. INSULATION TREATMENT -
   STEP 1 - DIP CORE HEATED TO 105°C TO 115°C INTO FIND NO. 15 FOR 3 MINUTES. DRAIN FOR 4 MINUTES AND BAKE FOR 2 HOURS AT 170°C.
   STEP 2 - DIP CORE HEATED TO 170°C INTO FIND NO. 16 FOR 3 MINUTES. DRAIN FOR 4 MINUTES AND BAKE FOR 2.5 HOURS AT 170°C. REPEAT STEP 2 TWO MORE TIMES FOR A TOTAL OF 3 DIPS AND BAKES OF STEP 2.
4. CONNECTOR TO BE USED WITH AMP TOOLING.
5. BRAZED CONNECTIONS PER MIL-B-7883.
6. USE FIND NO. 12 ONE LAYER AND OVERLAP FIND NO. 10 AND 11 .50 INCH.

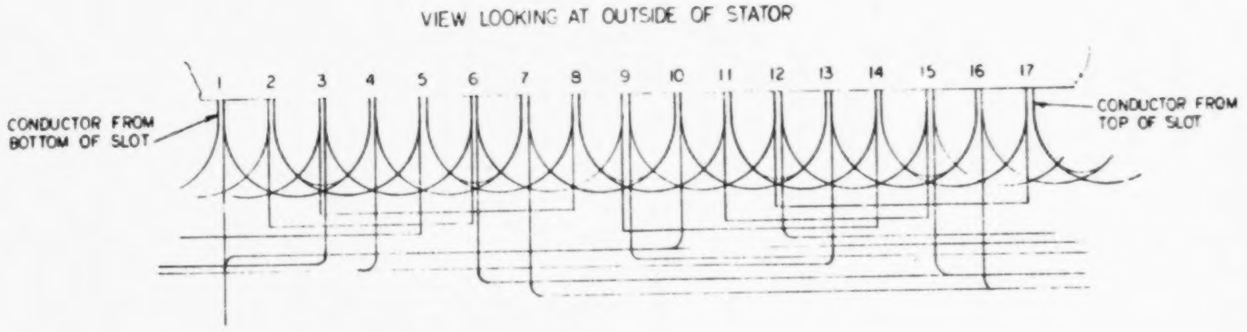
ME 6115-545-34/9-5(1) C4

**Figure 9-5. Stator Winding and Coil Connection (400 Hz) (Sheet 1 of 2)**



TYPICAL WINDING FORM

SCHEMATIC WINDING DIAGRAM
(SEE INTERNAL CONNECTION DIAGRAM SH. 3)


VIEW LOOKING AT OUTSIDE OF STATOR
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
CONDUCTOR FROM BOTTOM OF SLOT
CONDUCTOR FROM TOP OF SLOT

COIL INSERTION SEQUENCE 212/121/AND REPEAT 11 TIMES
NUMBER OF COILS
IN GROUP TYP

ME 6115-545-34/9-5(2)

Figure 9-5. Stator Winding and Coil Connection (400 Hz)
(Sheet 2 of 2)

Table 9-4. Rotor Winding Data (400 Hz)

| | |
|---|---|
| Resistance | 1.43 ohms at 25° C |
| Connection | 1 ckt, series, see schematic diagram |
| Conductor | 4 of AWG #15 (0.0571) |
| Turns per coil | 30 |
| No. of pole and coils | 24 |

(4) Rotor dip and bake.

(a) Preheat wound core for one hour in forced convection oven to 170° C.

(b) Dip hot wound core in varnish, connection end up, for three minutes.

(c) Remove wound core from varnish and drain, connection end up, for four minutes.

(d) Rotate wound core so connection end is down and drain one minute.

(e) Bake wound core with slots in horizontal position for two and one-half hours, at 170° C, in forced convection oven.

(f) Repeat paragraphs (b) through (e) above two more times so that a total of 3 dips and bakes is applied.

(g) The varnished wound rotor should be examined for complete coverage, uniform coverage with no strings or bends and with openings between extended position of slot tubes free of varnish, blistering or peeling, and complete cure, with tack-free surface and good bonding strength.

### 9-5. Exciter Repair and Rebuild.

a. Repair.

(1) Replace or rebuild any defective parts.

(2) Apply varnish to any damaged areas of insulation.

b. Rebuild.

(1) Exciter stator. See figure 9-7 and table 9-5, and perform the procedures provided in paragraph 9-4 (1) and (2).

(2) Exciter rotor. Proceed as follows:

(a) All wound cores will have leads connected and tied on the inside diameter of end turns.

(b) All connections will be brazed using brazing alloy per MIL-S-15395 as a filler material. End connections forming pigtails will be fusion welded as much as possible with addition of brazing alloy per above.

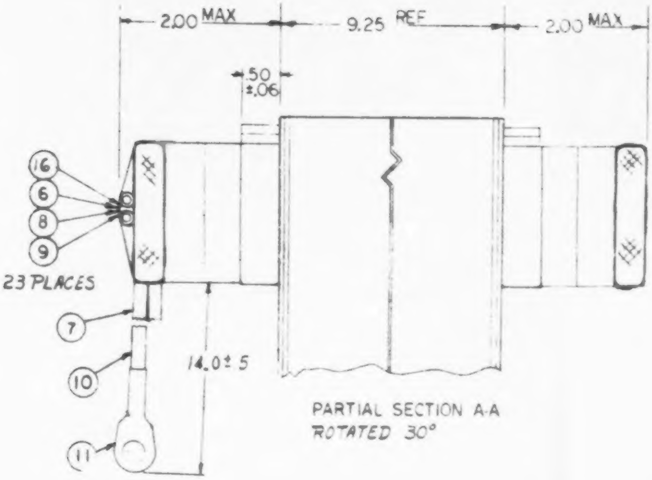
(c) All connections in the rotor winding will be covered with sleeving MIL-I-3190/3. Tape should be 1/2-inch lapped over connections and extended 3/8-inch beyond connection.

(d) For binding end turns use glass roving.

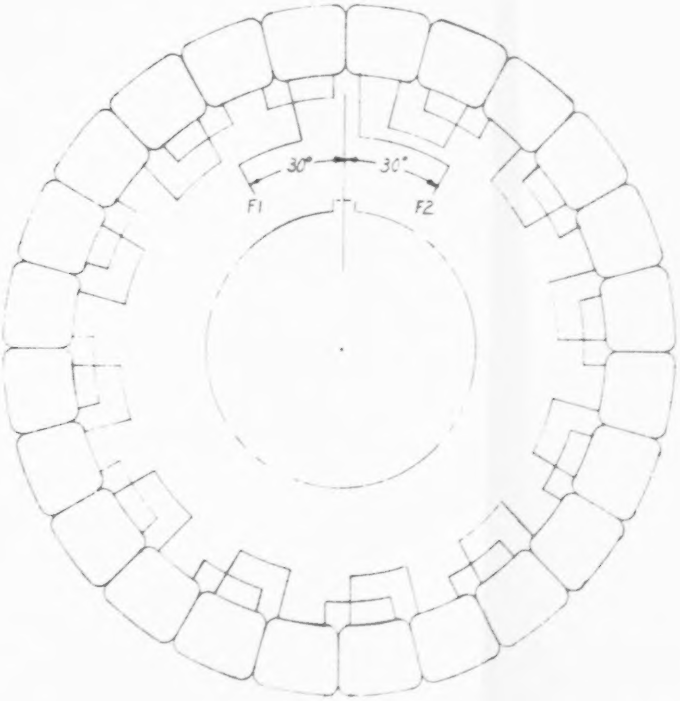
(e) The rotor end turns and connections are bound and laced in two stages.

Table 9-5. Exciter Stator Winding Data (50/60 and 400 Hz)

| | |
|---|---|
| Type of winding | Salient pole, dc |
| No. of slots and coils | 10 slots 10 coils |
| No. of coils per group | 1 |
| Turns per coil | 196 |
| Span | 1 - 2 |
| Conductor | 1 of AWG #21 (0.0285) 1 of AWG #22 (0.0253) |
| Resistance | 3.2 ohms at 25° C |
| Connection | 2 circuit (see fig. 9-7) |

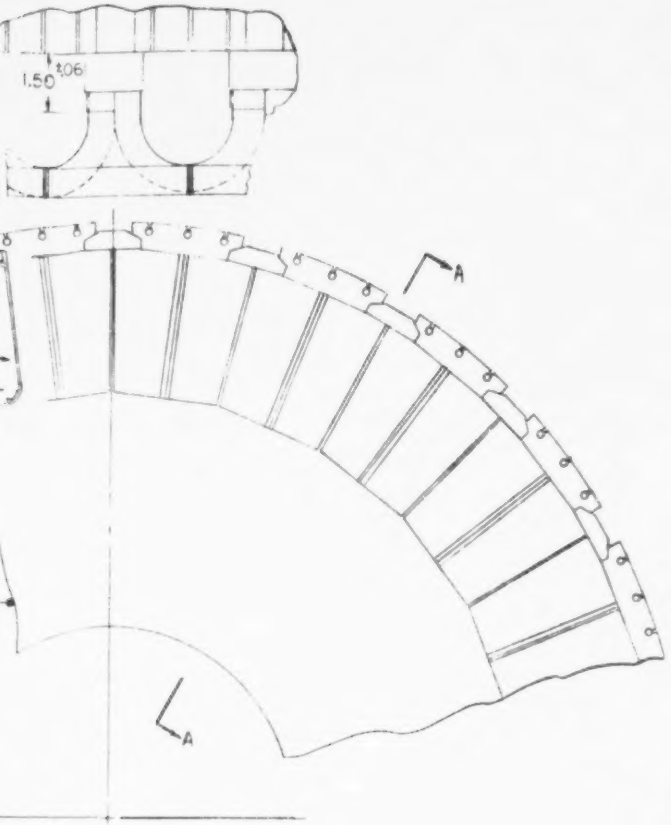

2.00 MAX
9.25 REF
2.00 MAX
.50 ±.06
16
6
8
9
23 PLACES
7
10
11
14.0 ± 5

PARTIAL SECTION A-A
ROTATED 30°



SCHEMATIC DIAGRAM

| | |
|---|---|
| RESISTANCE | |
| CONNECTION | |
| CONDUCTOR | |
| TURNS PER COIL | |
| NO OF POLE AND COILS | |
| WI | |



| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION |
|---|---|---|
| 16 | AR | SLEEVING |
| 15 | AR | VARNISH |
| 14 | AR | VARNISH |
| 13 | AR | TAPE |
| 12 | AR | ROVING |
| 11 | 2 | TERMINAL |
| 10 | AR | WIRE |
| 9 | 23 | CONNECTOR |
| 8 | 2 | CONNECTOR |
| 7 | AR | SLEEVING |
| 6 | AR | SLEEVING |
| 5 | 24 | SLOT INSULATION |
| 4 | 24 | SLOT INSULATION |
| 3 | 24 | WEDGE |
| 2 | AR | WIRE MAGNET AWG 15 |
| 1 | 1 | *WELDED CORE ASSEMBLY* |

LIST OF MATERIAL

| | |
|---|---|
| | 1.15-1.41 OHMS AT 25° C |
| | 1CKT, SERIES, SEE SCHEMATIC DIAG |
| | 4 OF AWG #15 (.0571) |
| | 30 |
| | 24 |

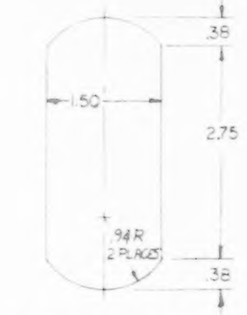
NDING DATA

NOTES

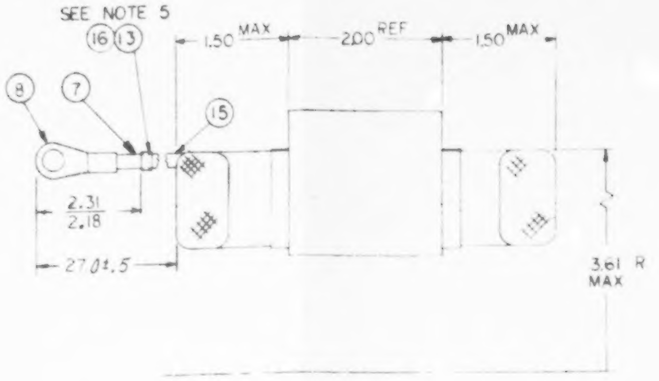
1. INTERPRET DWG PER MIL-STD-100
2. ASSEMBLY - ASSEMBLE COILS AND INSULATION PER THIS DRAWING. COLD CONN. FIND NO. 10 TO COIL LEADS USING FIND NO. 8 AND INSULATE USING FIND NO. 6 HELD IN PLACE WITH FIND NO. 13 WHILE INSERTING BOTH IN FIND NO. 7. COLD CONN. SERIES JOINTS USING FIND NO. 9 AND INSULATE USING FIND NO. 16. FIND NOS 6 AND 16 A MIN OF 50 INCH EITHER SIDE OF CONN. OVER EACH END TURN WRAP 20 TURNS OF FIND NO. 12 TO PROVIDE BANDING SUPPORT OF END TURNS AND SECURE WITH CONN TO END TURNS USING FIND NO. 12.
3. INSULATION TREATMENT -
   STEP 1 - DIP CORE HEATED TO 160°C INTO FIND NO. 14 FOR 3 MINUTES. DRAIN 10 MINUTES AND BAKE AT 160°C FOR 3 HOURS. REPEAT STEP 1 FOR A TOTAL OF 2 DIPS AND BAKES.
   STEP 2 - DIP CORE HEATED TO 170°C INTO FIND NO. 15 FOR 3 MINUTES. DRAIN FOR 4 MINUTES AND BAKE AT 170°C FOR 2.5 HOURS. REPEAT STEP 2 TWO MORE TIMES FOR A TOTAL OF 3 DIPS AND BAKES OF STEP 2.

ME 6115-545-34/9-6 C4

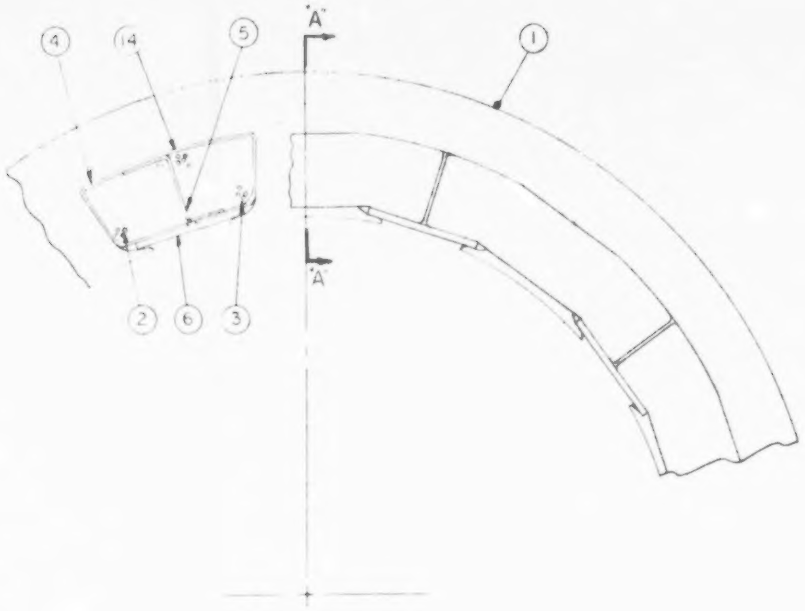
Figure 9-6. Rotor Winding and Coil Connection (400 Hz)



TYPICAL WINDING FORM

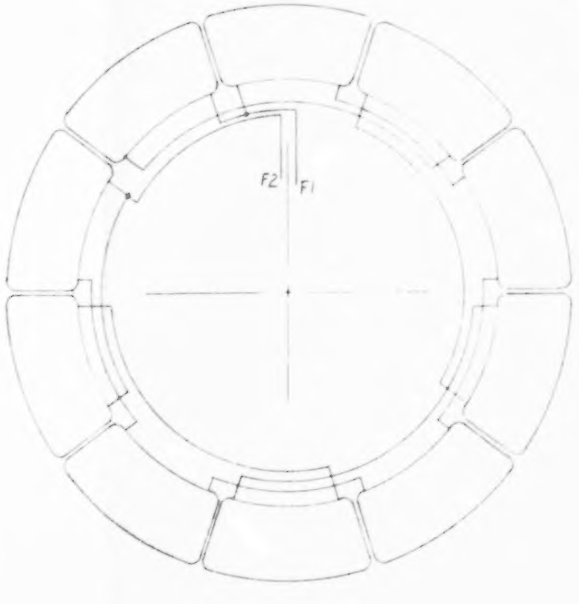


SECTION "A-A"



NOTES

1. INTERPRET DWG PER MIL-STD-100
2. ASSEMBLY - ASSEMBLE COILS AND INSULATION IN ACCORDANCE WITH DRAWING. BRAZE ALL CONNECTIONS USING FIND NO. 11. TAPE JOINTS WITH 3 LAYERS OF FIND NO. 9 TO COVER A MINIMUM OF .50 INCH EITHER SIDE OF JOINT. ALL CONNECTIONS TO BE SECURELY LACED TO END TURNS USING NO. 10.
3. INSULATION TREATMENT - DIP CORE HEATED TO 160°C INTO FIND NO. 12 FOR 1 MINUTE. DRAIN FOR 3 MINUTES AND BAKE FOR 1 HOUR AT 165°C. REPEAT TWO MORE TIMES FOR A TOTAL OF 3 DIPS AND BAKES.
4. BRAZE ALL CONNECTIONS PER MIL-B-7883.
5. ASSEMBLE FIND NO. 13 AND 16 PER SCHEMATIC DIAGRAM.



SCHEMATIC DIAGRAM

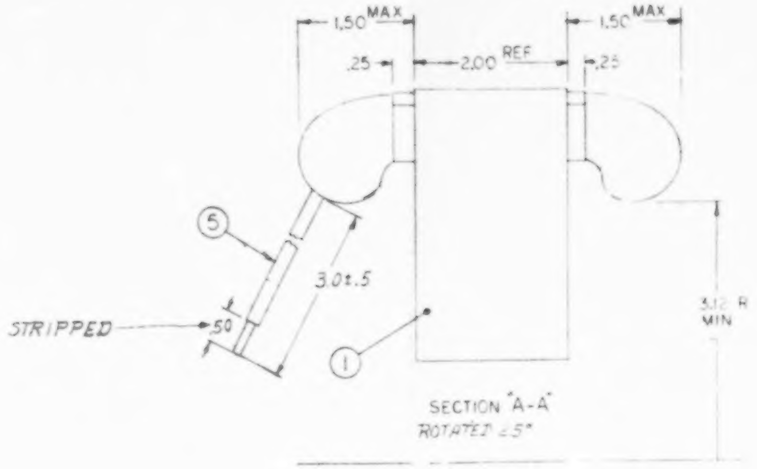
| WINDING DATA | |
|---|---|
| TYPE OF WINDING | SALIENT POLE, D.C. |
| NO OF SLOTS AND COILS | 10 SLOTS  10 COILS |
| NO OF COILS PER GROUP | 1 |
| TURNS PER COIL | 196 |
| SPAN | 1-2 |
| CONDUCTOR | 1 OF AWG #21(.0285)  1 OF AWG #22(.0253) |
| RESISTANCE | 2.90-3.54 OHMS AT 25°C |
| CONNECTION | 2 CIRCUIT SEE SCHEMATIC DIAGRAM |

| FIND NO | QTY REQD | NOMENCLATURE OR DESCRIPTION |
|---|---|---|
| 16 | 1 | LEAD TAG |
| 15 | AR | SLEEVING |
| 14 | AR | FILLER, SLOT |
| 13 | 1 | LEAD TAG |
| 12 | AR | VARNISH |
| 11 | AR | BRAZING ALLOY |
| 10 | AR | TIE CORD |
| 9 | AR | TAPE |
| 8 | 2 | TERMINAL |
| 7 | AR | WIRE |
| 6 | 10 | TOP STICK |
| 5 | 10 | SLOT INSULATION |
| 4 | 10 | SLOT INSULATION |
| 3 | AR | WIRE MAGNET AWG #22 (.0253) |
| 2 | AR | WIRE MAGNET AWG #21 (.0285) |
| 1 | 1 | WELDED CORE ASS'Y |

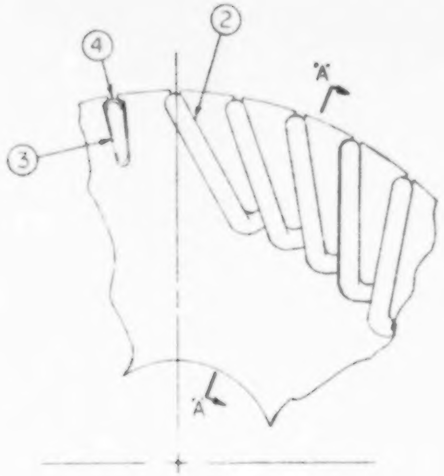
LIST OF MATERIAL

ME 6115-545-34/9-7 C4

**Figure 9-7. Exciter Stator Winding and Coil Connection**

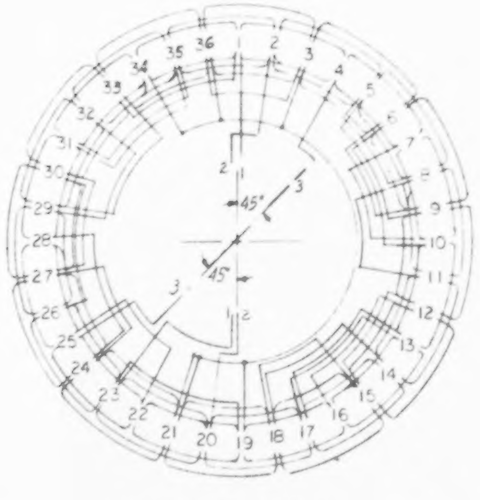


SECTION "A-A"
ROTATED 45°



NOTES

1. INTERPRET DWG PER MIL-STD-100
2. ASSEMBLY - ASSEMBLE COILS AND INSULATION IN ACCORDANCE WITH DRAWING. BRAZE ALL CONNECTIONS USING FIND NO. 9. TAPE JOINTS WITH 3 LAYERS OF FIND NO. 7. EXTEND FIND NO. 7 TO COVER A MINIMUM OF .50 INCH EITHER SIDE OF JOINT. ALL CONNECTIONS TO BE SECURELY LACED TO END TURNS USING FIND NO. 8.
3. INSULATION TREATMENT -
   STEP 1 - DIP CORE HEATED TO 160°C INTO FIND NO. 10 FOR 3 MINUTES. DRAIN FOR 10 MINUTES AND BAKE AT 160°C FOR 3 HOURS. REPEAT STEP 1 FOR A TOTAL OF 2 DIPS AND BAKES.
   STEP 2 - DIP CORE HEATED TO 170°C INTO FIND NO. 11 FOR 3 MINUTES. DRAIN FOR 4 MINUTES AND BAKE AT 170°C FOR 1 HOUR. REPEAT STEP 2 TWO MORE TIMES FOR A TOTAL OF 3 DIPS AND BAKES OF STEP 2.
4. BRAZE ALL CONNECTIONS PER MIL-B-7883.



SCHEMATIC DIAGRAM

| WINDING DATA (50/60 Hz) | |
|---|---|
| TYPE OF WINDING | 3 PHASE |
| NO. OF SLOTS AND COILS | 36 SLOTS 36 COILS |
| NO OF COILS PER GROUP | 6 GROUPS OF 2 24 GROUPS OF 1 |
| TURNS PER COIL | 3 |
| SPAN | 1-4 |
| CONDUCTOR | 5 OF AWG #16 (.0508) |
| CONNECTION | 2 CIRCUIT WYE, SEE SCHEMATIC DIAG |
| RESISTANCE | .0192-.0234 OHMS AT 25° C |
| INSERTION SEQUENCE | 211/112/111/121/111 AND REPEAT |

| WINDING DATA (400 Hz) | |
|---|---|
| TYPE OF WINDING | 3 PHASE |
| NO OF SLOT AND COILS | 36 SLOTS 36 COILS |
| NO OF COILS PER GROUP | 6 GROUPS OF 2 24 GROUPS OF 1 |
| TURNS PER COIL | 5 |
| SPAN | 1-4 |
| CONDUCTOR | 3 OF AWG #16 (.0508) |
| CONNECTION | 2 CIRCUIT WYE (SEE SCHEMATIC DIAGRAM) |
| RESISTANCE | .042-.051 OHMS AT 25° C |
| INSERTION SEQUENCE | 211/112/111/121/111 AND REPEAT |

| FIND NO | QTY REQD | NOMENCLATURE OR DESCRITION |
|---|---|---|
| 11 | AR | VARNISH |
| 10 | AR | VARNISH |
| 9 | AR | BRAZING ALLOY |
| 8 | AR | TIE CORD |
| 7 | AR | TAPE |
| 6 | | |
| 5 | AR | WIRE |
| 4 | 36 | TOP STICK |
| 3 | 36 | SLOT INSULATION |
| 2 | AR | WIRE MAGNET AWG #16 |
| 1 | 1 | WELDED CORE ASSEMBLY |
| LIST OF MATERIAL | | |

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**Figure 9-8. Exciter Rotor Winding and Coil Connection**

(f) Using a zig-zag motion, place a band of one continuous piece over and near the end of the end turns. Using enough spread to keep the band below the line of the rotor outer diameter, secure the end by lapping over the end. Binding must not be loose.

(g) After all coils are inserted and bound as in (a) above, lace continuously using at least two turns at each location with a slip tie on the second turn. Lace at each tooth, separating the top coils and the bottom coils.

(h) Place the connection bundle beneath the end turns and lace as in (g), being sure to lace in the connection bundle.

(i) Refer to table 9-6 and figure 9-8 for exciter rotor winding data.

## 9-6. Generator Reassembly and Installation.

a. Reassembly. See figure 9-1 to reassemble the ac generator.

(1) Balance plates should be shrunk on the shaft. Heat balance plates in an oven to approximately 200° C. Place heated balance plate on shaft and with a pipe or sleeve with a bore slightly larger than the balance plate bore, tap the balance plate onto the shaft until it registers against the shaft shoulder.

(2) The coupling hub is reassembled to the rotor assembly by placing the hub in an oven and heating to 200° C. The hot coupling hub then slides on the shaft and key.

(3) The diodes should be placed on the rotating diode assembly, using a thermal conduction lubricant such as Burndy "Penetrox A" or equivalent. Do not allow the lubricant on the threads of the diode or the torque measurements will be incorrect.

### CAUTION

> There are three forward polarity diodes (arrow towards threaded stud) and three reverse polarity diodes (arrow away from threaded stud). The diodes must be assembled with the three forward polarity diodes on one heat sink and the three reverse polarity diodes on the other heat sink. Assemble the diodes with nuts and lockwashers, using a torque wrench. Assemble with 30 inch pounds of torque.

(4) Use balance weights assembled in holes of balance plate to dynamically balance complete rotor assembly within 2 inch-ounces.

(5) Tighten screw (41) to 950-1100 inch-pounds and bend up corners of strips (42) against a flat side of screw (41).

(6) At assembly apply light coating of grease (MIL-G-23827) to the bearing bore of the end shield. Also add 0.9 to 1/4 cu. in. (1.0 - 1.5 tablespoons) of grease to the bearing cavity on the outboard side of the bearing and 0.45 to 0.7 cu. in. (0.5 to 0.75 tablespoons) of grease to the bearing cavity on the inboard side of the bearing.

b. Installation. Refer to paragraph 2-12.

## 9-7. Generator Tests after Reassembly.

Perform tests 1, 2 and 3 of operating tests (refer to table 16-1).

Table 9-6. Exciter Rotor Winding Data (50/60 and 400 Hz)

| | |
|---|---|
| Type of winding | 3 phase |
| No. of slots and coils | 36 slots 36 coils |
| No. of coils per group | 6 groups of 2 24 groups of 1 |
| Turns per coil | 3 for 50/60 Hz - 5 for 400 Hz |
| Span | 1-4 |
| Conductor | 5 of AWG #16 (0.0508) - 50/60 Hz<br>3 of AWG #16 (0.0508) - 400 Hz |
| Connection | Parallel 2 circuit WYE, (see fig. 9-8) |
| Resistance | 0.023 ohm at 25° C - 50/60 Hz<br>0.050 ohm at 25° C - 400 Hz |
| Insertion sequence | 211/112/111/121/111 and repeat |

# CHAPTER 10

## DAY TANK ASSEMBLY REPAIR INSTRUCTIONS

### 10-1. General.

a. The day tank is provided to receive fuel from the main fuel tank through the fuel transfer pump and primary fuel filters and to supply fuel to the fuel injection pump via the secondary fuel filter.

b. The day tank is mounted on a support bracket above the fuel injection pump on the right side of the engine. Fuel is transferred by two electric pumps from the main fuel tank to the day tank.

### 10-2. Removal.

Refer to the Operator and Organizational Maintenance Manual to remove the day tank.

### 10-3. Cleaning, Inspection and Repair.

a. Cleaning.

(1) Clean exterior of day tank with cleaning solvent, Federal Specification P-D-680 and dry thoroughly.

(2) Remove all gasket and adhesive materials from mating surfaces.

(3) Flush tank thoroughly with hot water or steam under pressure. Clean interior with solvent and dry thoroughly.

b. Inspection

(1) Inspect hardware and threaded areas for damage.

(2) Inspect fuel passages for obstructions.

(3) Inspect interior to insure that scale and sediment have been removed.

c. Repair.

(1) Repair all threaded areas with a fine mill file. Retap threaded holes.

(2) Use compressed air to clear fuel passages.

### 10. 4 Installation.

Refer to the Operator and Organizational Maintenance Manual.

# CHAPTER 11

# LIFTING FRAME REPAIR INSTRUCTIONS

## 11-1. General.

The lifting frame provides center support for the housing and mounts to lift eye devices for hoisting.

## 11-2. Removal and Disassembly.

a. Remove generator set housing and lifting frame components. Refer to the Operator and Organizational Maintenance Manual.

b. Refer to Operator and Organizational Maintenance Manual and remove the fuel tank to allow removal of bottom bolts holding supports. (30 and 31, fig. 11-1.)

c. Remove and disassemble the lifting frame as illustrated in figure 11-1.

## 11-3. Cleaning and Inspection.

Refer to Operator and Organizational Maintenance Manual.

a. Clean the lifting frame with cleaning solvent, Federal Specification P-D-680.

b. Use a stiff bristled brush to remove heavily concentrated grease and dirt.

c. Inspect the lifting frame for cracks and distortion.

## 11-4. Repair.

Repair the lifting frame by replacement of damaged parts. (fig. 11-1.)

## 11-5. Reassembly and Installation.

Reassemble and install lifting frame in reverse order of disassembly. (fig. 11-1.)

KEY to Fig. 11-1.

| | |
|---|---|
| 1. | Nut |
| 2. | Washer |
| 3. | Screw |
| 4. | Bracket |
| 5. | Nut |
| 6. | Washer |
| 7. | Screw |
| 8. | Washer |
| 9. | Bracket |
| 10. | Nut |
| 11. | Washer |
| 12. | Screw |
| 13. | Nut |
| 14. | Washer |
| 15. | Screw |
| 16. | Nut |
| 17. | Washer |
| 18. | Screw |
| 19. | Bracket |
| 20. | Bracket |
| 21. | Screw |
| 22. | Washer |
| 23. | Nut |
| 24. | Washer |
| 25. | Screw |
| 26. | Washer |
| 27. | Washer |
| 28. | Washer |
| 29. | Nut |
| 30. | Support |
| 31. | Support |
| 32. | Rivet |
| 33. | Plate |

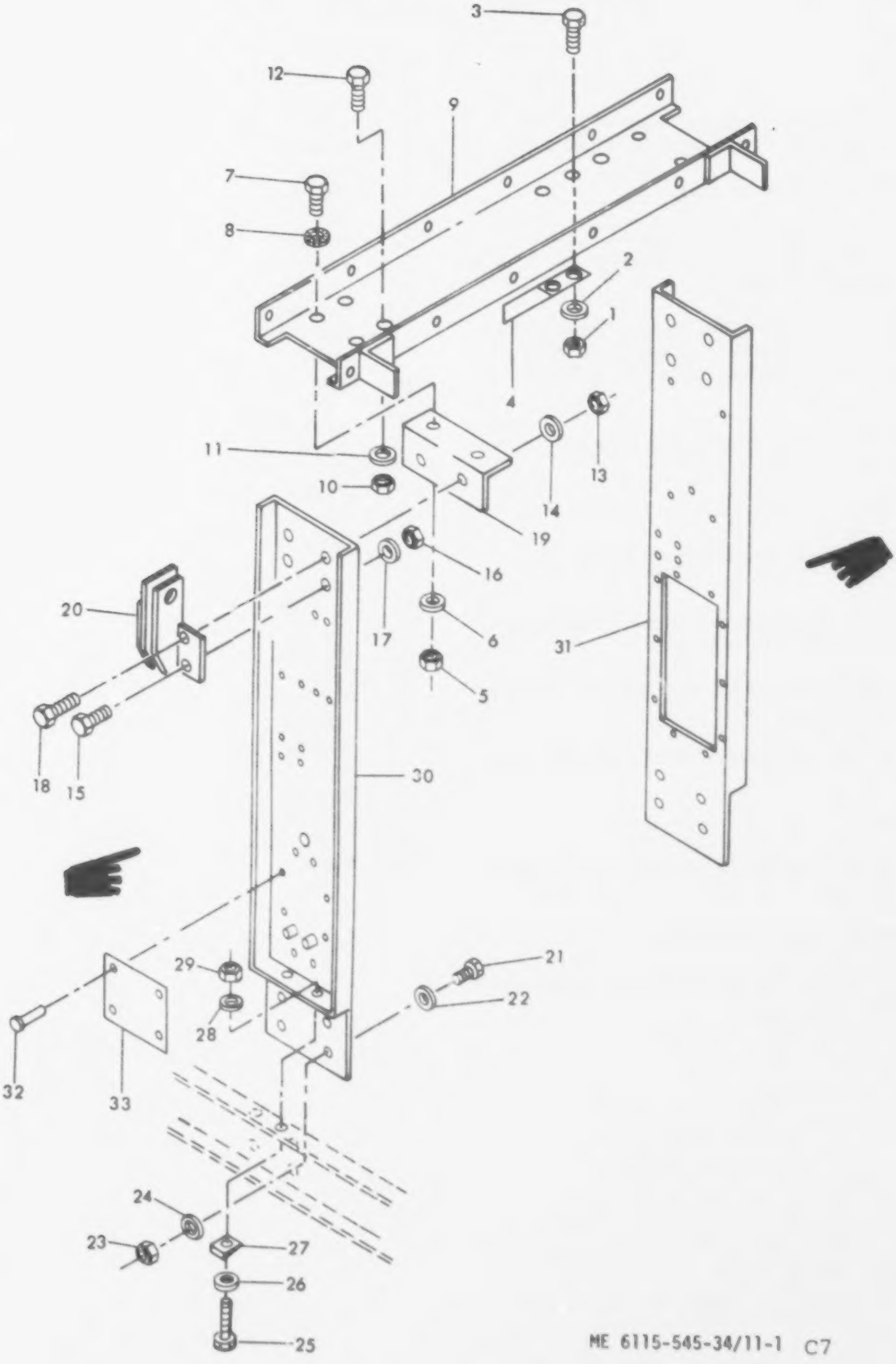
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Figure 11-1. Lifting Frame Assembly

# CHAPTER 12

## COOLING GROUP REPAIR INSTRUCTIONS

### 12-1. General.

a. The cooling group consists of the radiator grille, shutter assembly and the shutter thermostat.

b. The radiator is mounted at the front end of the engine generator set just behind the grille and shutter assembly. It is equipped with inlet and outlet hose connections, a filler cap and an overflow tube. A drain valve is located on the lower right side of the radiator. A shroud and fan guard are mounted on each side behind the radiator, enclosing the fan.

c. The radiator shutter is mounted on the front of the radiator. The shutter control is mounted on the lower right side of the radiator and operates by thermal expansion. A plunger inside the thermostat, which is affected by temperature in the radiator, actuates the linkage system to the shutter. The shutter will remain closed until the engine warms up, at which time it will open upon action of the shutter control. A control lever is provided for manual operation of the shutter control in case of thermostat failure.

d. The fan is located behind the radiator on the front of the engine. Driven by belts when the engine is running the fan draws cooling air through the doors at the rear of the unit and exhausts it through the radiator core, shutter and grille.

### 12-2. Radiator Assembly Removal.

A malfunction of the radiator, shutter assembly or thermostat is usually indicated by an abnormally high reading on the coolant temperature gauge located on the engine control panel. To isolate the cause proceed as follows:

a. If the shutter assembly is closed, operate the manual control and open it. If the temperature begins to drop toward normal, the probable cause is a faulty shutter thermostat. (Refer to the Operator and Organizational Maintenance Manual).

b. Open the radiator fill cap and check for a sufficient amount of coolant. Add coolant if necessary and observe temperature gauge for a drop in temperature.

c. Shut the engine down. Examine the pulley belts for tension. If they are tight examine the fan for bent or broken blades and freedom of motion.

d. When it is determined that there has been a failure of the radiator, fan, or shutter assembly, remove the radiator, grille, shutter assembly, shroud and fan guard. (Refer to the Operator and Organizational Maintainance Manual).

### 12-3. Radiator and Shutter Repair and Test.

a. Clean all parts with cleaning solvent Federal Specification P-D-680 and dry thoroughly with compressed air at 10 to 15 pounds pressure.

b. Inspect all hardware and threaded areas for damaged or crossed threads.

c. Inspect shutter control body for damage and proper operation.

d. Repair control assembly and shutter assembly by replacement of defective parts. (See figures 12-1 and 12-2).

e. Using compressed air, remove all dirt and foreign material from the radiator core.

(1) Solder or braze any radiator core leaks.

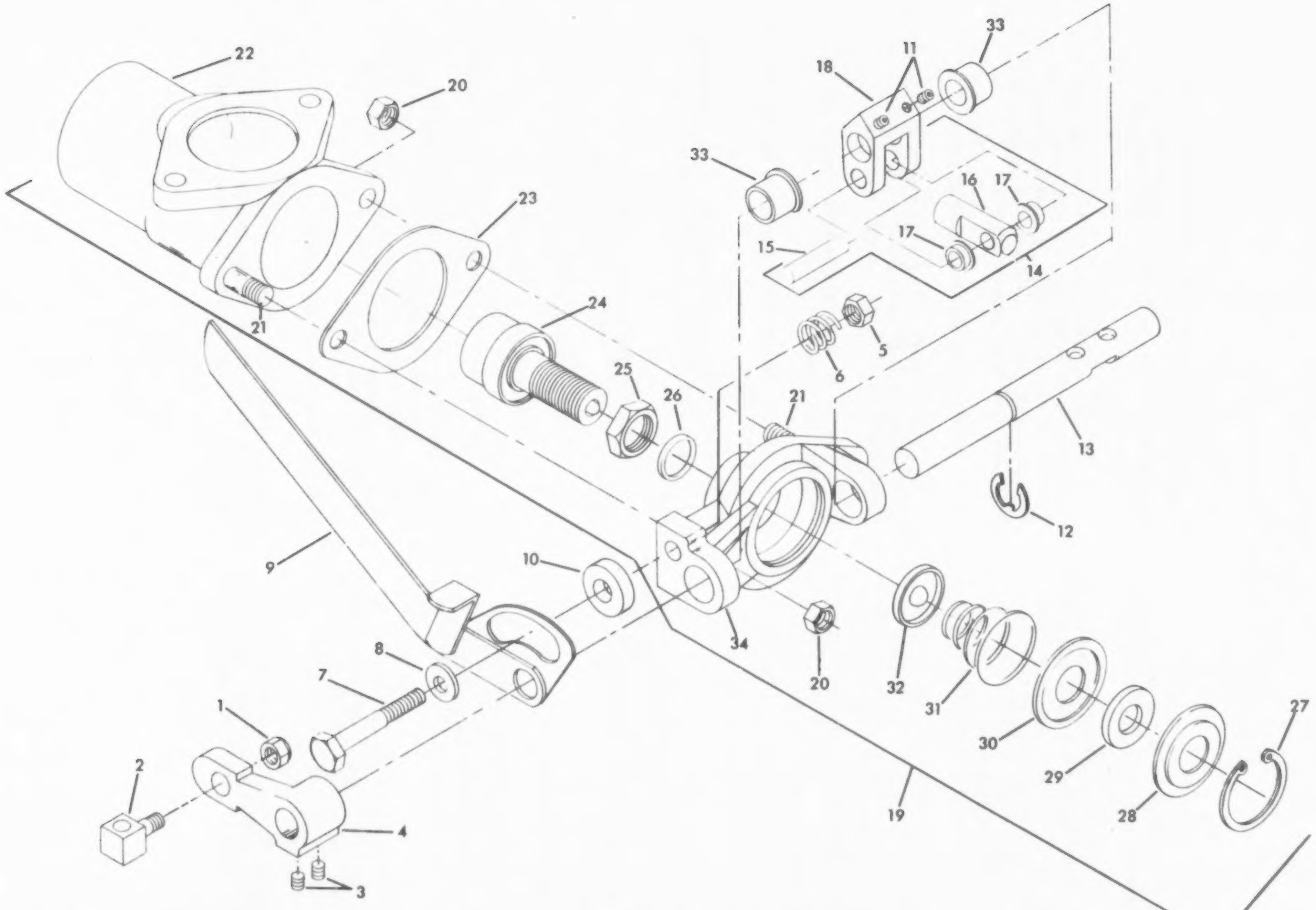
(2) Straighten bent cooling fins.

f. Replace all worn, damaged, or defective parts.

g. Test the radiator for leaks by placing the radiator with outlet connection sealed in a tank of water. Apply compressed air of 10 to 15 psi at filler opening and observe for leakage indicated by air bubbles in the water.

### 12-4. Radiator Assembly Installation.

Install the fan guard, shroud, radiator, shutter assembly, grille and shutter thermostat. (Refer to the Operator and Organizational Maintenance Manual.)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3

1. Nut
2. Block
3. Setscrew
4. Lever
5. Nut
6. Spring
7. Bolt
8. Washer
9. Lever
10. Spacer
11. Setscrew
12. Ring, Retaining
13. Shaft
14. Yoke and plunger assy
15. Pin
16. Plunger
17. Bearing
18. Yoke
19. Power element and flange assy.
20. Nut
21. Stud
22. Housing
23. Gasket
24. Thermostat
25. Nut
26. Preformed packing
27. Retaining ring
28. Seat
29. Felt
30. Seat
31. Spring
32. Seat
33. Bushing
34. Flange

Figure 12-1. Control Assembly

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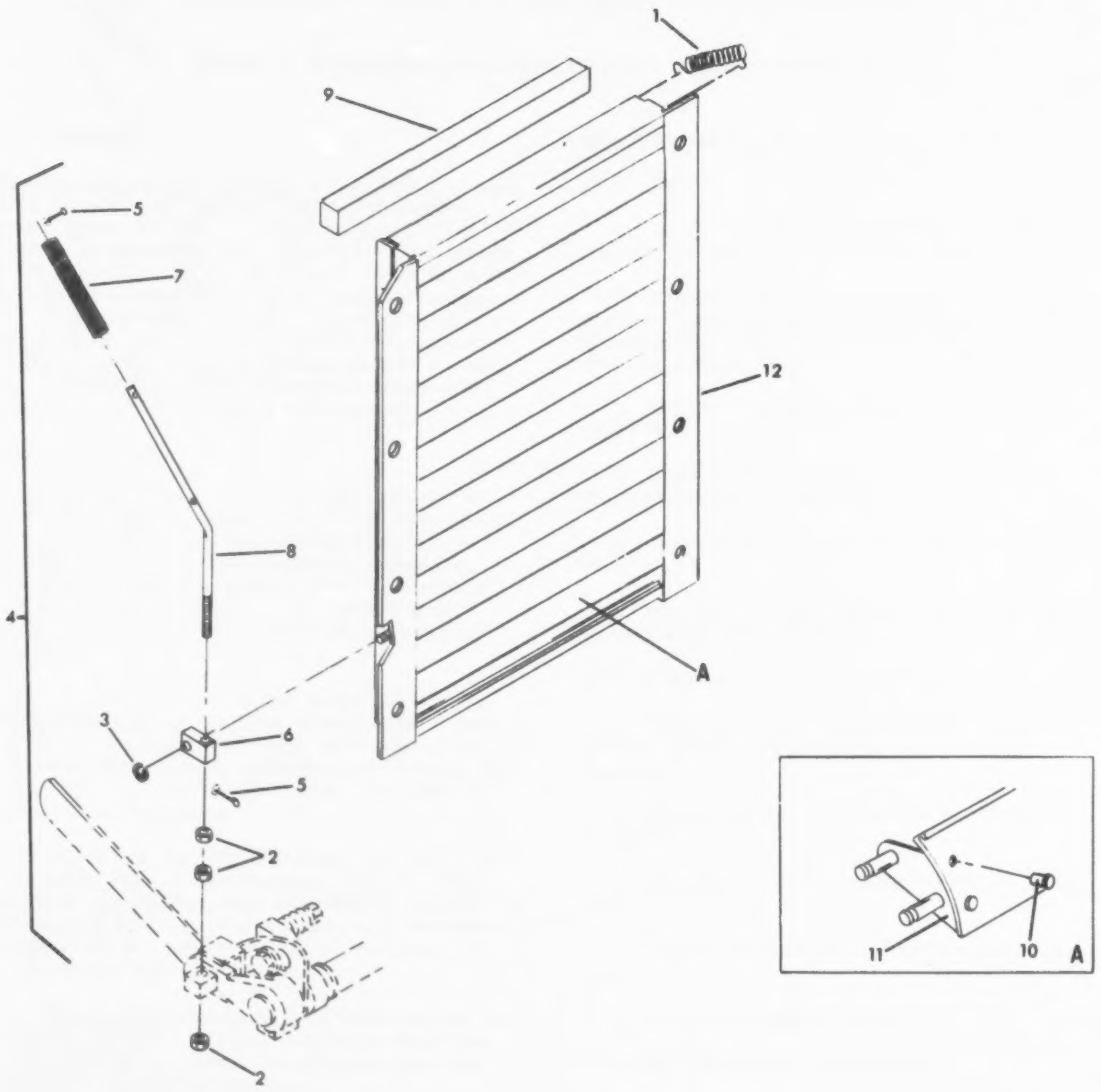
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1. Spring
2. Nut
3. Retaining ring
4. Rod Assy
5. Pin
6. Block
7. Spring
8. Rod
9. Tape
10. Rivet
11. Vane Assy
12. Shutter Assy

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Figure 12-2. Shutter Assembly

# CHAPTER 13

# HYDRAULIC ACTUATOR, SUMP AND FILTER REPAIR INSTRUCTIONS

## Section I. HYDRAULIC ACTUATOR (CLASS I, PRECISE SETS ONLY)

### 13-1. General.

The hydraulic actuator (figures 13-1 and 13-2) is part of the generator set electro-hydraulic governing system (para. 7-1 and 7-2) and is used to control the speed of the generator set. An error voltage sensed by the governor system control unit is magnetically amplified to control the power to energize the solenoid of the hydraulic actuator, thus changing the high pressure input oil into a differential pressure across the piston. This is accomplished by a solenoid controlled teeter bar within the actuator that controls the position of the actuator piston.

### 13-2. Malfunction.

A malfunction of the hydraulic throttle actuator is usually indicated by engine shutdown or overspeed when the START-STOP-RUN switch is transferred from the START to the RUN position, frequency drift observed on the frequency meters, sluggish response to load changes, or no response to load changes. To isolate the malfunction, proceed as follows:

a. Check for 4-6 Vdc at test points AB and CD (see figures 1-4 and 1-5) of electric governor control unit (A and D are positive), with engine operating. If voltage at either point is approximately 15 volts, the malfunction is a result of an opening in an actuator valve coil, or connecting circuit.

b. Check that the throttle linkage (see figure 13-1) is not badly worn or disconnected. A worn linkage can cause sluggish response or drifting frequency. A disconnected or broken linkage can cause overspeed, shutdown, or no response. Also check linkage for binding due to dirt or distortion.

c. Check condition of hydraulic filter and the level of hydraulic oil. Either a clogged or dirty filter or low oil level can reduce the hydraulic pressure required to operate the actuator.

d. Check pressure output of hydraulic actuator by removing plugs in ports A1 and A2 and inserting 0-400 psi range gages. The pressure at each port should be 160 ± 25 psi and equal, with engine operating under governor control. Operating under manual control, with J6 disconnected, the pressure at port A2 should be 180 ± 20 psi and approximately 50 psi higher than the pressure at port A1.

e. Check the transducer in the actuator for freedom of movement. The transducer must move freely for good response.

f. If any of the above examinations indicates that the actuator has failed, proceed with removal, disassembly and repair instructions.

### 13-3. Removal and Disassembly.

a. Clean all hydraulic fittings and couplings throughly to prevent contamination of system.

b. Remove drain plug on bottom of hydraulic sump and drain and discard hydraulic oil. (Refer to Operator and Organizational Maintenance Manual for draining procedures.)

c. Remove hydraulic actuator as illustrated in figure 13-1.

d. Remove four bolts securing bracket to actuator and remove bracket.

e. Disassemble actuator as illustrated in figure 13-2.

f. To remove connector (34) tag and unsolder all wires attached to connector.

### 13-4. Cleaning, Inspection and Repair.

a. Clean all parts thoroughly with cleaning solvent Federal Specification P-D-680 and dry thoroughly.

b. Inspect all parts for damage or defective condition.

c. Inspect ball joints and linkage for excessive wear.

d. Inspect actuator packing and piston for damage.

e. Replace all defective parts.

### 13-5. Reassembly and Installation.

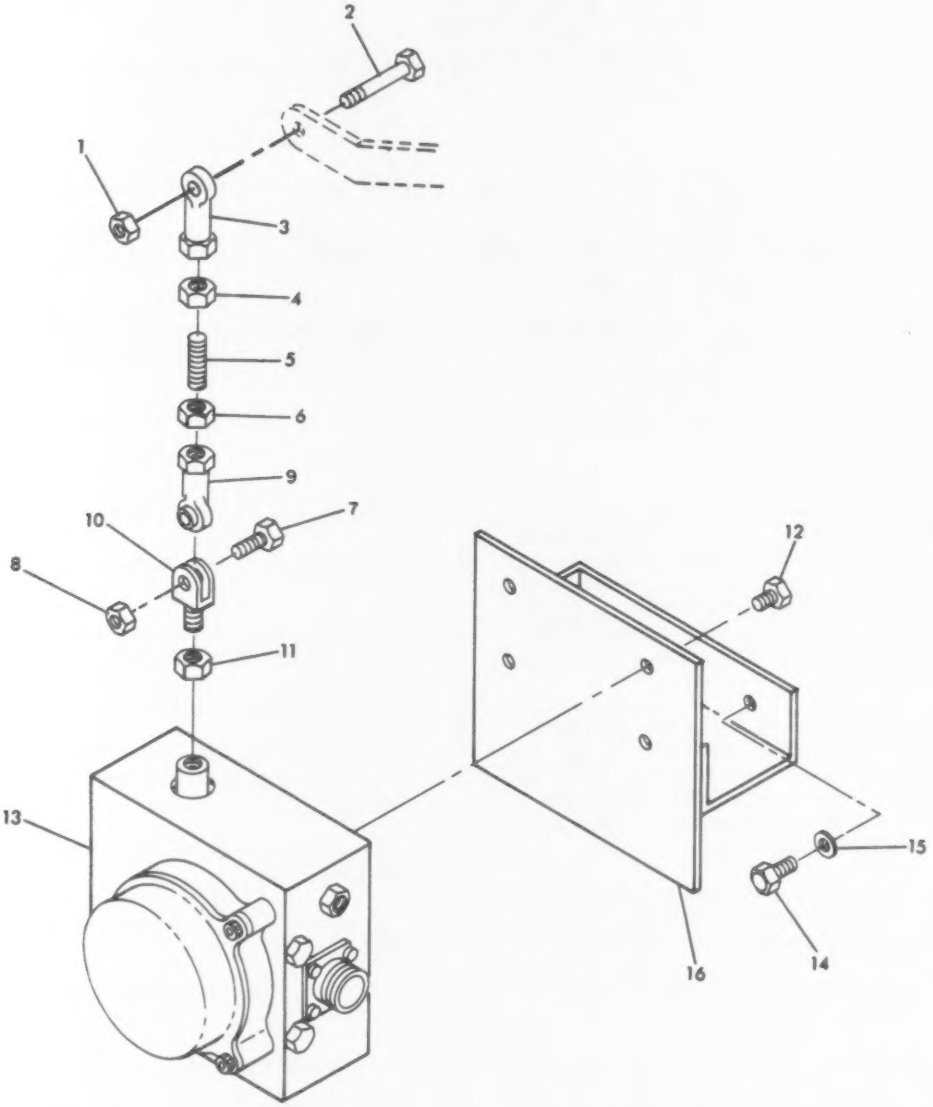
a. Reassemble the hydraulic actuator as illustrated in figure 13-2.

b. Install set screw (37) in core assembly (40) finger tight. Then install locknut (36). Proceed with care.

c. When installing connector (13), locate keyway at 12 o'clock position. (See figure 13-2.)

d. When installing connector (34), locate keyway at 6 o'clock position, viewed from top of valve block (48). (See figure 13-2.)

### 13-6. Actuator Valve and Piston Test.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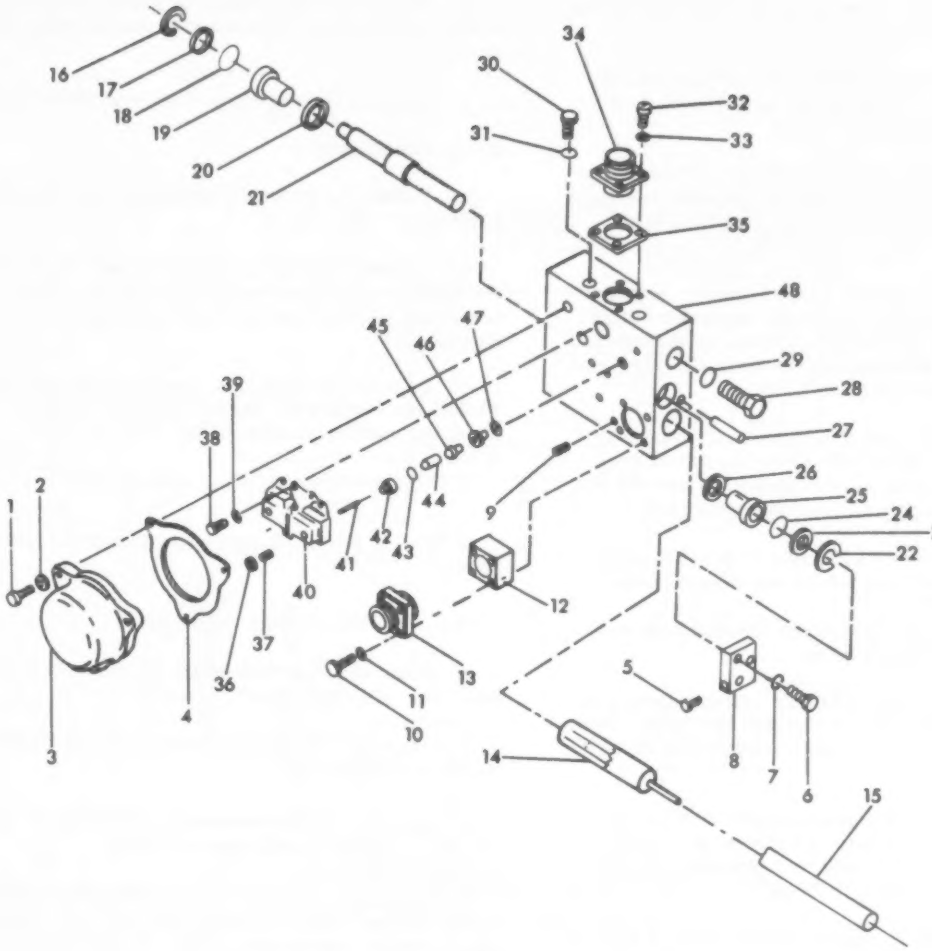
1. Nut
2. Screw
3. Rod end
4. Nut
5. Rod
6. Nut
7. Screw
8. Nut
9. Rod end
10. Clevis
11. Nut
12. Screw
13. Hydraulic actuator
14. Screw
15. Washer
16. Bracket

ME 6115-545-34/13-1

Figure 13-1. Hydraulic Actuator and Related Parts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1. Screw
2. Washer
3. Cover
4. Gasket
5. Setscrew
6. Screw
7. Washer
8. Plate
9. Setscrew
10. Screw
11. Washer
12. Spacer
13. Connector
14. Transducer assembly
15. Core
16. Retaining ring
17. Washer
18. Packing
19. Collar
20. Quad-ring
21. Piston
22. Retaining ring
23. Washer
24. Packing
25. Collar
26. Quad-ring
27. Pin
28. Filter plug assy
29. Packing
30. Plug
31. Packing
32. Screw
33. Washer
34. Connector
35. Gasket
36. Nut
37. Setscrew
38. Screw
39. Washer
40. Core armature assembly
41. Valve
42. Restrictor
43. Packing
44. Valve
45. Spacer
46. Restrictor
47. Packing
48. Block

ME 6115-545-34/13-2

Figure 13-2. Hydraulic Actuator

a. See figure 13-3 to perform the valve and piston test.

b. Connect dc power supply (ps) and switch (Sl) to J6 as illustrated. Connect voltmeter (Ml) with resistor (Rl) to pins A and B of J4.

c. Attach gage Gl and G2 as shown. Connect hydraulic power source (310 - 320 psi, 2 gpm) and gage G3 and provide a return line from port R to the hydraulic sump.

d. To adjust the valves, remove the large round cover and replace it with a similar diameter collar which will allow access to the adjustment screws and jam nuts. This is necessary to contain the hydraulic fluid which is ported within this cover.

e. With hydraulic power but no electric power, applied, adjust the valve with Allen set screw to yield 200 psi ± 10 psi at Al port (gage Gl) and 150 psi ± 10 psi at A2 port (gage G2). (See figure 13-3.)

CAUTION: Avoid overadjusting to prevent pressures or forces which could bend valve push rods.

f. After adjusting, lock Allen adjusting screws with jam nuts, and install cover.

g. Set Sl to the center position (solenoid coils in series). Apply 350 ± 20 ma through the coils. Pressures at Al and A2 ports shall remain the same (para 13-6.e).

h. Set switch Sl to connect power (PS) to coil L2 and apply 700 ma ± 40 ma. Pressure at Al port (gage Gl) shall be 310 to 400 psi. pressure at A2 port (gage G2) shall be 0 to 20 psi.

i. Set switch Sl to connect power (PS) to coil Ll and apply 700 ma ± 40 ma. Pressure at Al port (gage Gl) shall be 0 to 40 psi and pressure at A2 port (gage G2) shall be 310 to 400 psi.

13-7. Throttle Position Transducer Test.

a. With voltmeter (Ml), resistor (Rl) and 120 (+ 1%, 60 Hz) power source connected as shown in figure 13-3, move piston to fully open throttle position.

b. With the transducer body locked in place by its set screw, loosen the transducer core set screw and move the core relative to the body until a minimum voltage (0.5 to 2.5 volts) is obtained on the transducer secondary, as indicated on Ml.

c. Move the piston gradually towards the fully closed throttle position. The transducer secondary voltage, indicated by meter Ml shall increase in a linear manner to a maximum of 48 to 55 volts.

d. Repeat these adjustments until the transducer secondary voltage increases linearly from the lowest possible value to a maximum value over the entire 1.0 inch displacement of the piston.

e. When final adjustment is made, lock the transducer core in place with the transducer core set screw.

f. Remove the gages, meter, and power supplies.

13-8. Installation.

a. Install the hydraulic actuator with attaching hardware. (fig. 13-1.)

b. Connect hydraulic pressure and return lines to the actuator pressure and return parts. Different line sizes prevent inadvertent crossing of lines. (fig. 13-2.)

c. Connect electrical connectors J24 and J25. Electrical connectors cannot be interchanged due to differing number of pins. (fig. 13-2.)

d. Attach rod-ends, shaft and clevis.

e. Adjust the linkage in accordance with para. 13-9.

13-9. Throttle Linkage Adjustment.

a. Place the Stop-Run-Start switch in the RUN position. (DO NOT start the set.)

b. Place the battle short switch in the OVERRIDE or UP position.

c. Remove the bolt connecting the linkage rod to the fuel injection pump shut-off arm.

d. Starting at the full counter clockwise position, move the fuel injection pump shut-off arm clockwise until a slight resistance is felt. When this resistance is felt, hold the shut-off arm in that position.

NOTE

> This resistance is the fuel injection pump linkage coming into contact with the arm which moves the metering valve and starts in the direction of no fuel.

e. Move the actuator piston to the full OPEN (DOWN) position.

f. Make the necessary adjustment to the linkage rod, such that it will fit between the actuator piston and the fuel injection pump shut-off arm.

g. Start the generator set. Refer to the Operator and Organizational Maintenance Manual.

h. Observe the frequency meter on the panel in the control cubicle.

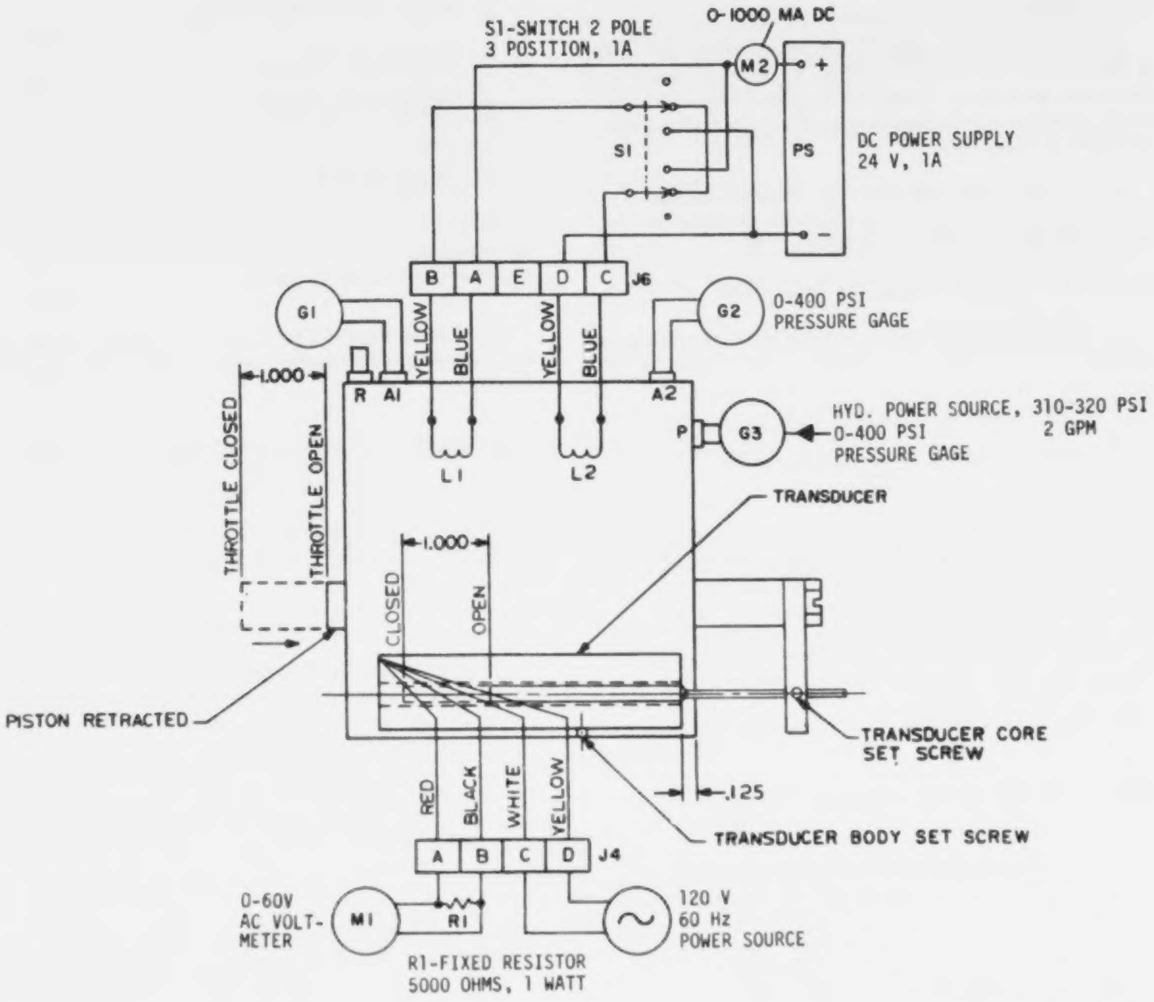
S1-SWITCH 2 POLE
3 POSITION, 1A
0-1000 MA DC
M2
+
S1
PS
DC POWER SUPPLY
24 V, 1A
−
B
A
E
D
C
J6
G1
G2
0-400 PSI
PRESSURE GAGE
YELLOW
BLUE
YELLOW
BLUE
1.000
R
A1
A2
THROTTLE CLOSED
THROTTLE OPEN
P
G3
HYD. POWER SOURCE, 310-320 PSI
2 GPM
0-400 PSI
PRESSURE GAGE
L1
L2
TRANSDUCER
1.000
CLOSED
OPEN
PISTON RETRACTED
TRANSDUCER CORE
SET SCREW
.125
RED
BLACK
WHITE
YELLOW
TRANSDUCER BODY SET SCREW
A
B
C
D
J4
0-60V
AC VOLT-
METER
M1
R1
120 V
60 Hz
POWER SOURCE
R1-FIXED RESISTOR
5000 OHMS, 1 WATT

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Figure 13-3. Hydraulic Actuator Tests, Schematic Diagram

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i. Adjust the governor in accordance with para. 7-8.

j. (Delete)

## Section II. HYDRAULIC SUMP AND FILTER (CLASS 1, PRECISE SETS ONLY)

### 13-10. General.

a. The hydraulic sump is mounted on the left side of the engine, on Class 1 precise generator sets. The sump acts as a reservoir for the hydraulic oil pump, used to supply hydraulic power to the hydraulic throttle actuator.

b. The hydraulic oil filter is mounted on the sump and provides protection against contaminant in the hydraulic oil pressure system.

### 13-11. Removal, Cleaning and Inspection.

Refer to the Operator and Organizational Maintenance Manual.

### 13-12. Repairs.

a. Repair threaded holes by retapping.

b. Repair cracks by welding.

c. Replace all defective parts.

d. Replace a defective filter.

### 13-13. Equipment Test.

If the electro-hydraulic actuator has been renewed or repaired, refer to Chapter 16, Section II and conduct the following tests.

a. Frequency and voltage regulation, stability, and transient response test, short term. (para 16-15.)

b. Frequency adjustment range test. (para 16-16.)

# CHAPTER 14

# ENGINE ASSEMBLY AND COMPONENTS REPAIR INSTRUCTIONS

## Section I. ENGINE ASSEMBLY

### 14-1. General.

The engine assembly provides the mechanical power to drive the main generator. It consists of a six-cylinder, turbocharged, diesel engine; battery-charging alternator, speed switch, electric starter and fuel pump. In addition, on precise generator sets, a hydraulic pump is provided. Maintenance instructions for the components of the engine assembly are provided in Sections II through XVII.

### 14-2. Removal.

Refer to paragraph 2-13 and remove the engine assembly, if required for the repair action to be taken.

### 14-3. Disassembly.

a. Place engine assembly on an engine stand utilizing engine stand adapter plate and spacers.

b. Disassemble the engine to the extent required by following procedures given in Sections II through XVII.

### 14-4. Inspection and Repair.

Inspect and repair engine assembly assemblies, subassemblies, and components as described in Sections II through XVII.

### 14-5. Reassembly.

Reassemble the engine assembly by following the procedures provided in Sections II through XVII.

### 14-6. Testing.

a. Service engine lube oil and fuel systems with proper oil and fuel. (Refer to Operator and Organizational Maintenance Manual.)

b. Connect engine assembly to a suitable engine dynamometer equipped with a cooling system and means of monitoring engine oil pressure, coolant temperature, and engine rpm.

c. Pre-run Checks.

(1) Manually turn engine over a minimum of two revolutions and check for binding and mechanical interference. Correct cause of any binding or interference prior to starting.

(2) With the fuel injection pump solenoid de-energized, crank the engine until oil pressure appears on the oil pressure gauge. Crank the engine an additional 15 seconds to insure oil is in all parts of the lube oil system.

(3) Recheck oil level and top off lube oil sump.

d. Engine Operational Check.

(1) With the dynamometer throttle set to the idle position and the fuel injection pump solenoid energized, crank the engine until the engine starts.

(2) Allow the engine to run at idle for 30 seconds, shut down engine and inspect for signs of leakage.

(3) Restart engine and allow to run at low idle for 10 minutes.

NOTE

Monitor oil pressure and coolant temperature at all times during this test, also check for unusual noise or vibrations. If at any time the oil pressure falls below 20 psi, the coolant temperature exceeds 222° F, or if noise or vibrations occur, discontinue test run.

(4) Operate engine at 1800 rpm at 1/2 load for 30 minutes.

(5) Operate the engine at 1800 rpm at full rated load for 1 hour.

(6) Check to see that the engine will produce the following brake horsepower.

| | | |
|---|---|---|
| 1500 rpm | - | 100 bhp |
| 1800 rpm | - | 120 bhp |
| 2000 rpm | - | 130 bhp |

(7) Operate the engine with no load for five minutes at 1800 rpm.

(8) Shut down and inspect engine for coolant, oil and leaks.

### 14-7. Installation.

Refer to paragraph 2-14 and install the engine assembly in the generator set.

## Section II. BATTERY CHARGING ALTERNATOR

### 14-8. General.

a. The 28 volt, 35 ampere battery charging alternator system is specifically designed for applications which require enclosed brush and slip ring construction. All of the aluminum casting and exposed parts are coated or plated to prevent corrosion. Both front and rear bearings are sealed and lubricated for life.

b. The brush assembly, enclosed by the rear housing cover, positions the brushes and provides the necessary pressure for good electrical contact with the slip rings. The voltage adjusting rheostat is a screwdriver adjustment accessible through a hole in the rear cover of the alternator. Remove battery charging alternator in accordance with Operator and Organizational Maintenance Manual.

### 14-9. On Equipment Test.

a. Rear Cover Removal. With the engine generator set stopped remove the 3 self tapping screws securing the rear cover of the battery charging alternator to the alternator housing. Remove the rear cover plate and leave it suspended by the attached wiring. Remove the 40 ampere fuse from its receptacle.

CAUTION

Insulate all wiring to the rear cover plate by inserting insulating material between the alternator housing and wiring to the rear cover plate.

b. Voltage Regulator Test Connections. Connect the test equipment to the alternator as shown in figure 14-1.

c. Voltage Regulator Test and Adjustment.

(1) Start the engine, allow a few minutes for warm up. Assure that the alternator drive speed is between 2000 to 3000 rpm. Indicated frequencies for 50, 60 or 400 Hz will provide the required battery charging alternator drive speeds for the respective engine-generator sets.

(2) Observe the test ammeter. A test ammeter reading in excess of 10 amperes is indicative of low batteries. If the test ammeter reading exceeds 10 amperes, remove the jumper from the 1/4 ohm 50 watt resistor thereby reducing alternator output current, by its insertion in the circuit.

(3) Observe the test voltmeter. The test voltmeter should indicate 28.0 Vdc ± .3 V at 75 degrees F.

(4) If the test voltmeter does not indicate the required voltage, use a small screw driver to adjust the rheostat on the voltage regulator to raise or lower the charging voltage.

(5) Shut down the engine-generator set and disconnect the test equipment.

d. Alternator Output Test Connections. Connect the test equipment to the alternator as shown in figure 14-1.

(1) This test will determine if the alternator is capable of producing its minimum rated output. This is an evaluation of the rotor, stator and all diodes and their ability to produce current. While maximum output depends on alternator temperature, the minimum acceptable output is used for reference. The charging system is also tested under partial load to determine if excessive voltage loss exists between the alternator and the battery through the circuit conductors.

(2) Start the engine-generator set, run the engine at approximately 750 RPM. If the test ammeter indicates less than 10 amperes charge, slowly apply the load across the battery until the ammeter indicates 10 amperes. Let the engine run in this manner for 5 minutes to stabilize component temperatures within the alternator and its integral solid state regulator.

(3) Note voltage loss incurred by moving the positive voltmeter lead from the positive output terminal to the battery positive post, with the alternator producing 10 amperes. If the loss exceeds 0.2 volts, check for poor connections or undersized conductors, repair as necessary.

(4) Increase set speed to rated speed (50, 60 or 400 Hz). Increase load on the battery causing the alternator to deliver its maximum current capacity of 35 amperes indicated on the test ammeter.

(5) Shut down the engine-generator set and disconnect the test equipment.

e. Voltage Protector Test Connections.

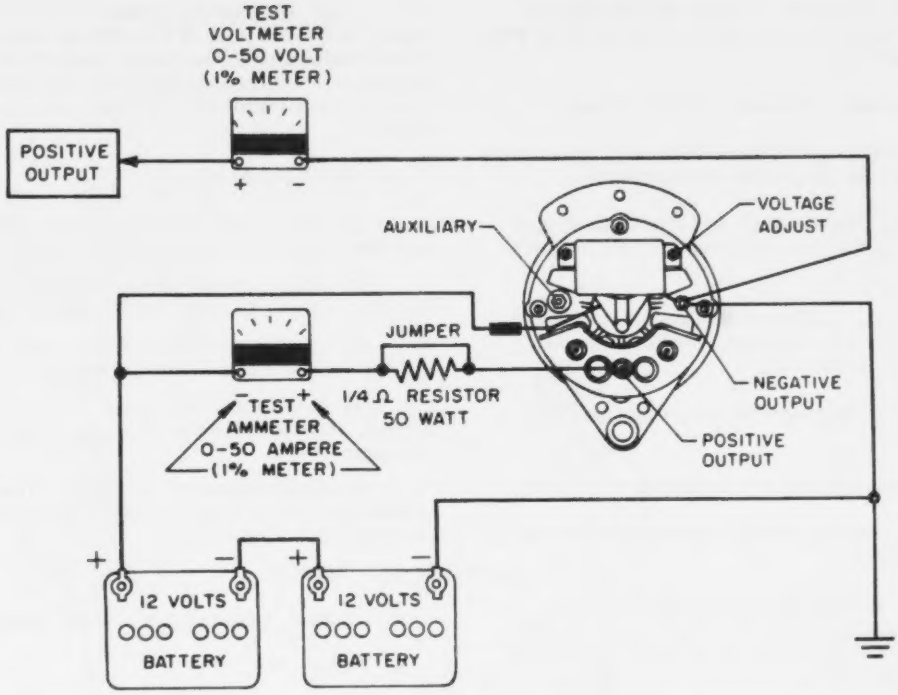
(1) The voltage protector test configuration is that which occurs when the rear cover of the battery charging alternator is removed from the alternator housing, with the additional connection of the test voltmeter according to polarity, to the positive and negative output terminals.

(2) Start the engine-generator set, adjust the throttle to obtain rated speed, run a few minutes to normalize temperature of the charging system, note the charging voltage.

(3) Remove one cable from, one battery post, and note the charging voltage.

(4) If the charging voltage without the battery in the circuit exceeds 31.0 volts, the voltage protector is defective and must be replaced.

(5) Shut down the engine-generator set. Dis-


TEST
VOLTMETER
0-50 VOLT
(1% METER)
POSITIVE OUTPUT
+
−
AUXILIARY
VOLTAGE ADJUST
JUMPER
1/4 Ω RESISTOR 50 WATT
− TEST +
AMMETER
0-50 AMPERE
(1% METER)
NEGATIVE OUTPUT
POSITIVE OUTPUT
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+
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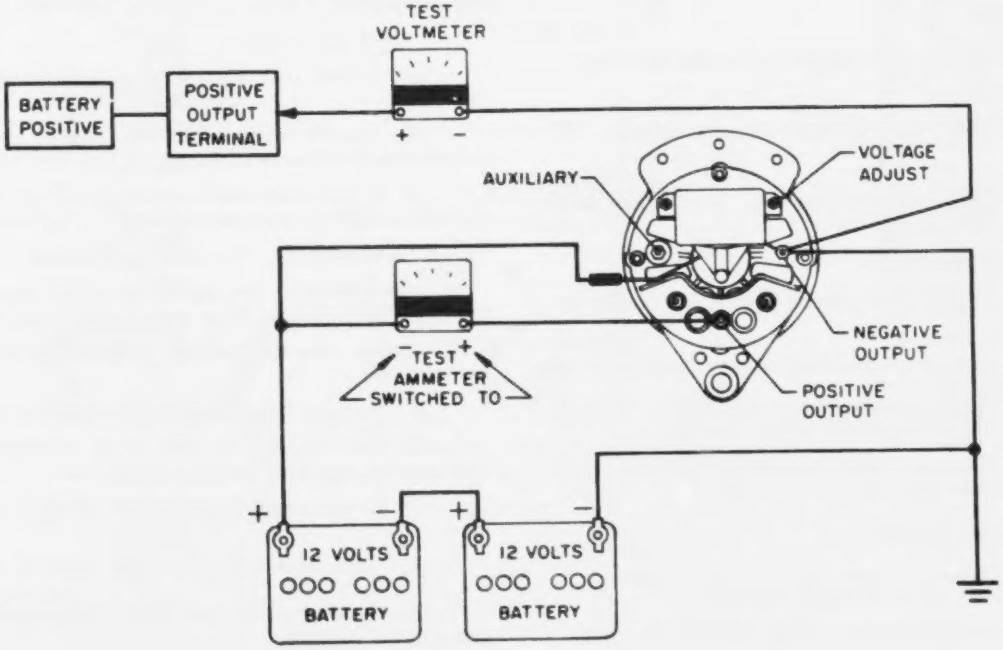
BATTERY
12 VOLTS
BATTERY

VOLTAGE REGULATOR TEST CONNECTIONS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POSITIVE OUTPUT TERMINAL
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VOLTAGE ADJUST
− TEST +
AMMETER
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NEGATIVE OUTPUT
POSITIVE OUTPUT
+
−
+
−
12 VOLTS
BATTERY
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ALTERNATOR OUTPUT TEST CONNECTIONS

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Figure 14-1. Voltage Regulator and Alternator Test

connect the test voltmeter, replace the 40 ampere fuse and reassemble the rear plate to the housing with 3 self tapping screws.

14-10. Disassembly, Cleaning and Inspection.

a. Disassembly. See figure 14-2 and disassemble the battery charging alternator as illustrated.

b. Cleaning. Blow out all dirt from inside and wipe interior and exterior surfaces with a clean dry cloth.

c. Inspection. Inspect all components of alternator assembly for heat damage, excessive wear, broken parts, and corrosion.

(1) Inspect bearings for rough motion or seizure.

(2) Inspect housing for distortion or cracks.

d. Diodes. Inspect diodes. Perform following check with multimeter.

(1) With multimeter on RX1 scale, check continuity in opposite direction. This check should show a resistance of less than 20 ohms in one direction and OPEN CIRCUIT in the reverse direction.

(3) A high resistance or low resistance in both directions indicates a defective diode. Replace a defective diode.

e. Rotor.

(1) Inspect rotor shaft for scoring and distortion.

(2) Test rotor for short circuits using a growler.

(3) Check rotor resistance. Resistance value shall be 11 to 14 ohms.

f. Field Assembly.

(1) Inspect field assembly case for cracks or distortion.

(2) Inspect for openings in insulating materials.

(3) Check resistance with ohmmeter. Resistance value shall be approximately one ohm.

(4) Minimum insulation resistance (one terminal to ground) shall be one megohm.

g. Voltage Regulator.

(1) Inspect voltage regulator for cracks, broken leads or other physical damage.

(2) Perform the following tests for the voltage regulator. See figure 14-3.

(a) Connect the positive lead of an ohmmeter to the yellow lead of the voltage regulator and check resistance to the red lead of the voltage regulator. The correct resistance is 600 to 900 ohms.

(b) Connect the positive lead of an ohmmeter to the red lead of the voltage regulator and check resistance to the yellow lead of the voltage regulator. The resistance should be infinite. Replace voltage regulator if it fails inspection and/or tests.

h. Brush Assembly.

(1) Inspect for excessive wear, broken leads, dirt and electrical requirements.

(2) Check brush spring tension. Tension should be 4 to 6 ounces to move brush against spring.

(3) Check assembly for excessive wear. Replace if 3/16 or less extends beyond bottom.

(4) Insultation test, point E to A, B, C, D, no circuit, indicate no short circuit, assembly correct. See figure 14-4.

(5) Continuity test, point A to B and C to D, continuous circuit indicates no open circuit, assembly correct. See figure 14-4.

14-11. Repair.

a. Diodes. Discard and replace defective diodes.

b. Rotor.

(1) Smooth minor scratches, burrs, and dents on shaft with fine mill file.

(2) If shaft is bent or rotor is beyond repair, replace defective battery charging alternator rotor.

c. Field Assembly.

(1) Repair insulation damage with air-dry varnish.

(2) Smooth minor scratches, burrs, and dents on machined surfaces of case with fine mill file.

(3) If field assembly is beyond repair, replace defective battery charging alternator field assembly.

14-12. Reassembly, Test and Installation.

a. Reassembly. See figure 14-2 and reassemble battery charging alternator except for cover assembly.

b. Tests. See figure 14-3 and perform the following tests:

(1) Remove black leads from negative terminal.

(2) Set ohmmeter to RX1 scale. Connect positive lead to regulator positive stud.

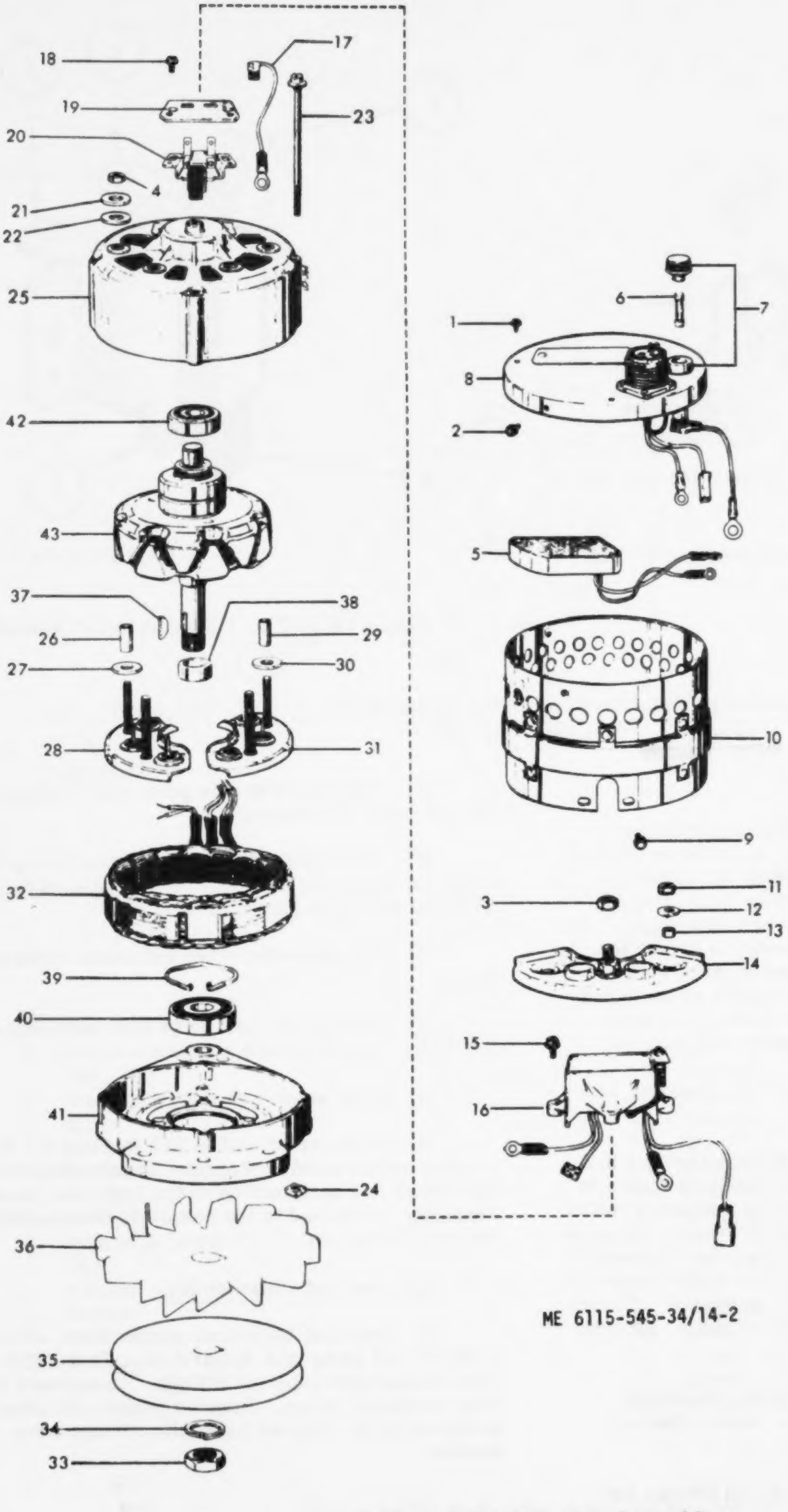
(3) Connect negative ohmmeter lead to negative stud.

(4) Ohmmeter should indicate 30 to 40 ohms.

(5) Reverse ohmmeter leads. Ohmmeter should read infinity.

(6) Re-install cover assembly.

c. Installation. Refer to the Operator and Organizational Maintenance-Manual and install the battery charging alternator.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1. Screw
2. Screw
3. Nut
4. Nut
5. Circuit protector
6. Fuse
7. Fuseholder
8. Cover assy
9. Screw
10. Housing
11. Nut
12. Washer
13. Sleeve
14. Diode assy
15. Screw
16. Regulator
17. Electrical lead
18. Screw
19. Cover
20. Brush assy
21. Washer
22. Washer
23. Bolt
24. Nut
25. Housing
26. Sleeve
27. Washer
28. Diode assy
29. Sleeve
30. Washer
31. Diode assy
32. Stator
33. Nut
34. Washer
35. Pulley
36. Fan
37. Woodruff key
38. Spacer
39. Retainer
40. Bearing
41. Housing
42. Bearing
43. Rotor assy

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Figure 14-2. Alternator Assembly

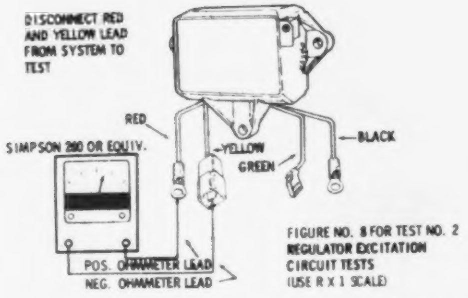
DISCONNECT RED AND YELLOW LEAD FROM SYSTEM TO TEST
RED
SIMPSON 260 OR EQUIV.
YELLOW
GREEN
BLACK
POS. OHMMETER LEAD
NEG. OHMMETER LEAD
FIGURE NO. 8 FOR TEST NO. 2 REGULATOR EXCITATION CIRCUIT TESTS (USE R X 1 SCALE)

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Figure 14-3. Regulator Excitation Test Circuit

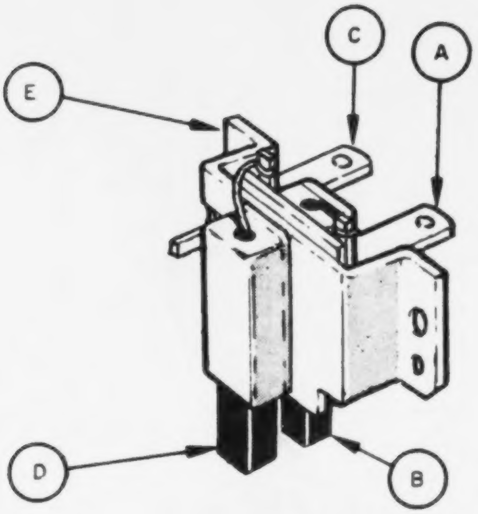

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Figure 14-4. Two Terminal Brush Assembly

## Section III. HYDRAULIC PUMP ASSEMBLY (CLASS 1, PRECISE SETS ONLY)

### 14-13. General.

The hydraulic pump assembly supplies oil under pressure to the electro-hydraulic actuator on Class 1 generator sets. The hydraulic pump is located on the left side of the engine at the rear of the timing gear housing and is driven by the hydraulic pump drive assembly. The drive assembly is driven by the camshaft gear and contains two tapered roller bearings which are lubricated by engine oil splashed by other gears in the timing gear train. The pump assembly is lubricated by circulating hydraulic oil.

### 14-14. Hydraulic Pump Malfunctions, Removal and Disassembly.

a. Symptoms and Isolation of Malfunction. A malfunction of the hydraulic sump is usually indicated by fluctuating frequency observed on the frequency meter as a result of erratic hydraulic oil pressure, sluggish response of the actuator to load changes as a result of low hydraulic oil pressure, or failure of the governor system due to loss of hydraulic oil pressure. To isolate a malfunction of the hydraulic oil pump, proceed as follows:

(1) Check hydraulic oil level by observing sight glass on hydraulic oil sump. Insure that oil level is sufficient.

(2) Check all hydraulic lines and fittings for signs of leakage.

(3) Carefully examine pump and mounting adapter for signs of leakage.

(4) Thoroughly clean area around fitting on pump for hydraulic line to filter and around drain valve on hydraulic pump.

(5) Remove drain valve and drain hydraulic oil.

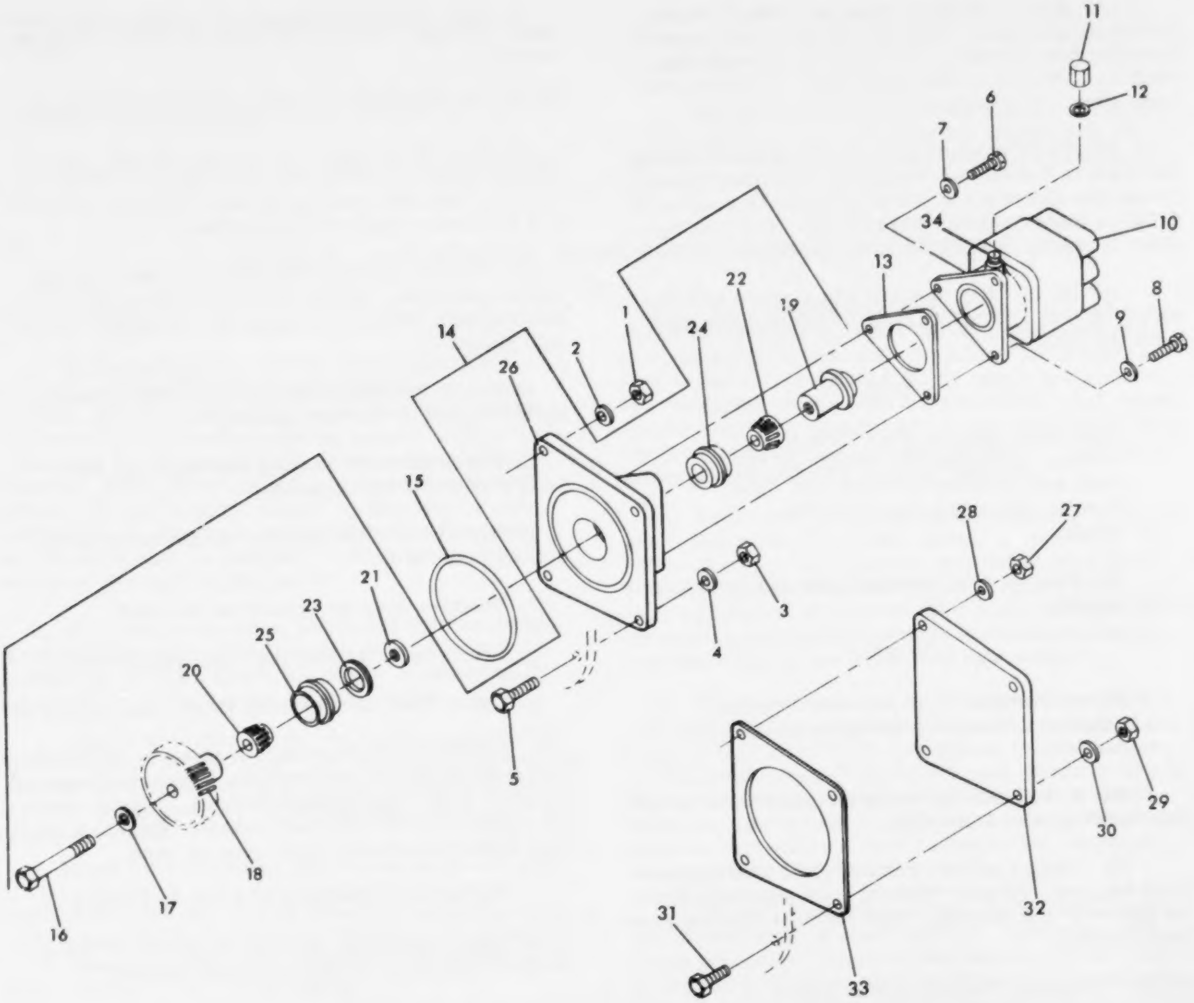
(6) Insert 0-400 psi gauge between pump and hydraulic line to throttle actuator.

(7) Refill sump and start engine.

(8) Pressure should be 310 to 330 psi. If the reading shows erratic pressure or low pressure, then there is a malfunction of the hydraulic pump assembly. Proceed to the removal, disassembly and repair procedures.

b. Removal and Disassembly.

(1) Open left hand area engine door, drain hydraulic oil pump and discard oil. Thoroughly clean area around hydraulic oil fittings. Disconnect lines from hydraulic pump. Remove pump as illustrated in figure 14-5. Cap all hydraulic fittings when opened.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1. Nut
2. Washer
3. Nut
4. Washer
5. Screw
6. Screw
7. Washer
8. Screw
9. Washer
10. Hydraulic pump
11. Cap
12. Washer
13. Gasket
14. Drive assy
15. Packing
16. Screw
17. Washer
18. Gear
19. Shaft
20. Bearing
21. Spacer
22. Bearing
23. Spacer
24. Bearing race
25. Bearing race
26. Housing
27. Nut
28. Washer
29. Nut
30. Washer
31. Screw
32. Plate
33. Gasket
34. Adjustment Control Screw

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Figure 14-5. Hydraulic Pump and Related Parts

(2) Secure the drive gear in a vise with protective copper jaws. Remove capscrew and washer securing gear to shaft. The fit of the gear to the shaft is 0.0017 to 0.0002 inch loose. Remove gear from shaft. If necessary, use gear puller.

(3) The clearance of the bearing assembly on the shaft is 0.0000 inch to 0.0013 inch interference fit and the clearance of the bearing in the housing is 0.000 to 0.002 inch interference fit. The bearing outer diameter is 1.980 to 1.981 inches.

(4) Place drive assembly in a press with the hydraulic pump mounting side down and drive shaft from the housing.

NOTE

When removing the shaft from the housing, one cone will remain on the shaft and the other will fall out. The bearing races will remain in the housing.

(5) Remove front bearing cone and cone spacer from housing.

NOTE

Do not intermix front and rear bearing cones and races if bearings are to be reused.

(6) If the bearings require replacement, press rear bearing cone from shaft.

(7) Using a puller, remove front bearing race from housing. Remove bearing race separator from its groove in the housing. Remove rear bearing race from housing.

14-15. Cleaning, Inspection, and Repair.

a. Wash all parts in cleaning solvent, Federal Specification P-D-680.

b. Inspect hydraulic pump drive gear and replace if gear is worn, scored, chipped, or has broken teeth.

c. Replace bearings if races or rollers are worn, pitted, or scored. Bearings must be replaced when rebuilding pump.

NOTE

The tapered bearings must be replaced as an assembly. The assembly consists of the bearing cones, cone spacer, races and race spacer. The spacers are factory selected to give the proper end clearance.

d. Replace all defective parts as required. Bearings, O-rings, and gaskets must be replaced during overhaul.

14-16. Reassembly, Installation, and Adjustment.

a. Place drive assembly in a press with the hydraulic pump mounting side down and press rear bearing race into housing so that it is approximately 1/4 inch below the mounting surface.

b. Position bearing race spacer in housing next to the rear race. Slowly press both the spacer and bearing race into the housing until the spacer snaps into place.

c. Press the front bearing race in the housing until it contacts the race spacer.

d. Press the rear bearing cone onto the shaft until it contacts the shoulder.

e. Install the shaft into the housing from the hydraulic pump side.

f. Position the cone spacer on the shaft.

g. Press the front bearing cone onto the shaft.

h. Install gear on shaft with washer and capscrew.

i. Lubricate bearings with engine oil. Tighten capscrew to 95-105 foot-pounds. Strike both ends of the shaft with a soft-headed hammer. Again tighten the capscrew to 95-105 foot-pounds. Shaft and bearings should turn freely when spun by hand.

j. The mounted end play is 0.001 to 0.013 inch.

k. Install hydraulic oil pump on hydraulic pump adapter with three screws and lock washer.

l. Use a new O-ring and install the hydraulic pump adapter and drive assembly and pump to the front support plate with lock washer, nuts and bolts; tighten the nuts securely.

m. Connect oil return line to pump.

NOTE

To facilitate assembly and prevent galling, coat all mating and bore surfaces of bearing with clean engine oil, or other suitable lubricant.

n. Connect a 0-400 PSI gauge with tee to the output of the hydraulic pump.

o. Connect hydraulic oil line between filter and pressure gauge.

p. Fill hydraulic system with hydraulic oil MIL-H-5606.

q. Start the engine. (Refer to Operator and Organizational Maintenance Manual).

r. Remove the hex cap (11, fig. 14-5) and washer (12), located on top of the pump housing, and adjust the slotted adjustment control screw (34) to obtain a pressure of 320 ± 10 psi.

s. Replace hex cap, shut down engine, drain hydraulic system, remove pressure gauge, connect hydraulic output line to pump, and refill system with hydraulic oil, MIL-H-5606.

## Section IV. SPEED SWITCH, TACHOMETER DRIVE AND ADAPTER

### 14-17. General.

a. The speed switch, driven by the camshaft through a tachometer drive assembly and an angle adapter, provides sequenced control of circuits during engine startup and protection against engine overspeed during operation. Three sets of contact elements, S9-1, S9-2, and S9-3, contained in the speed switch, are set to open, close, or transfer by centrifugal force at certain engine speeds. The speed switch drive gear is designed to drive the speed switch at one-half engine speed.

b. At an engine speed of 580 to 620 rpm (accelerating) element S9-1 transfers two sets of contacts, energizing the field flash circuit and de-energizing the crank relay to stop the starting motor.

c. On Class 1 sets, when the engine reaches the speed range of 1180 to 1220 rpm (Mode I); 1650 to 1700 rpm (Mode II) element S9-2 closes, energizing the electro-hydraulic governor which takes over control of engine speed.

d. Speed switch element S9-3 consists of two sets of contacts which are set to transfer at an engine speed 2425 ± 25 rpm to shut down the engine and prevent damage to the equipment. Shutdown is achieved by de-energizing the stop-run relay and the fuel solenoid, cutting off fuel to the engine.

e. Elements S9-1 and S9-2 reset at 100 rpm (decreasing) below actuation speed. Element S9-3 is manually reset by a pushbutton on the speed switch housing.

### 14-18. Speed Switch Removal.

Refer to Operator and Organizational Maintenance Manual for removal of the speed switch.

### 14-19. Speed Switch Tests, Adjustment, Repair and Installation.

a. Connect a variable speed drive device to the speed switch drive. The drive device must have a tachometer in order to determine the speed of the device in rpm's.

b. With an ohmmeter on the R1 scale, reading from the speed switch connector, check for the contact conditions of elements S9-1, S9-2, and S9-3 illustrated in figure 14-6.

c. When contact conditions are verified, as shown in figure 14-6, start variable drive and gradually increase speed, with ohmmeter connected to pins B and A. At a speed of 290 rpm's per minute, the ohmmeter should indicate that contact A-B opens. Hold the variable speed drive at that speed and transfer the ohmmeter leads to pins A and C. The ohmmeter should indicate a closed contact.

d. Leave the ohmmeter leads connected to pins A and C and gradually reduce speed. In the range of 190 to 210 rpm, the contacts of element S9-1 should reset to the condition illustrated in figure 14-6. To verify operation of element S9-1 contacts A and C, increase drive speed gradually and observe that the contacts close in the 290 to 310 rpm range.

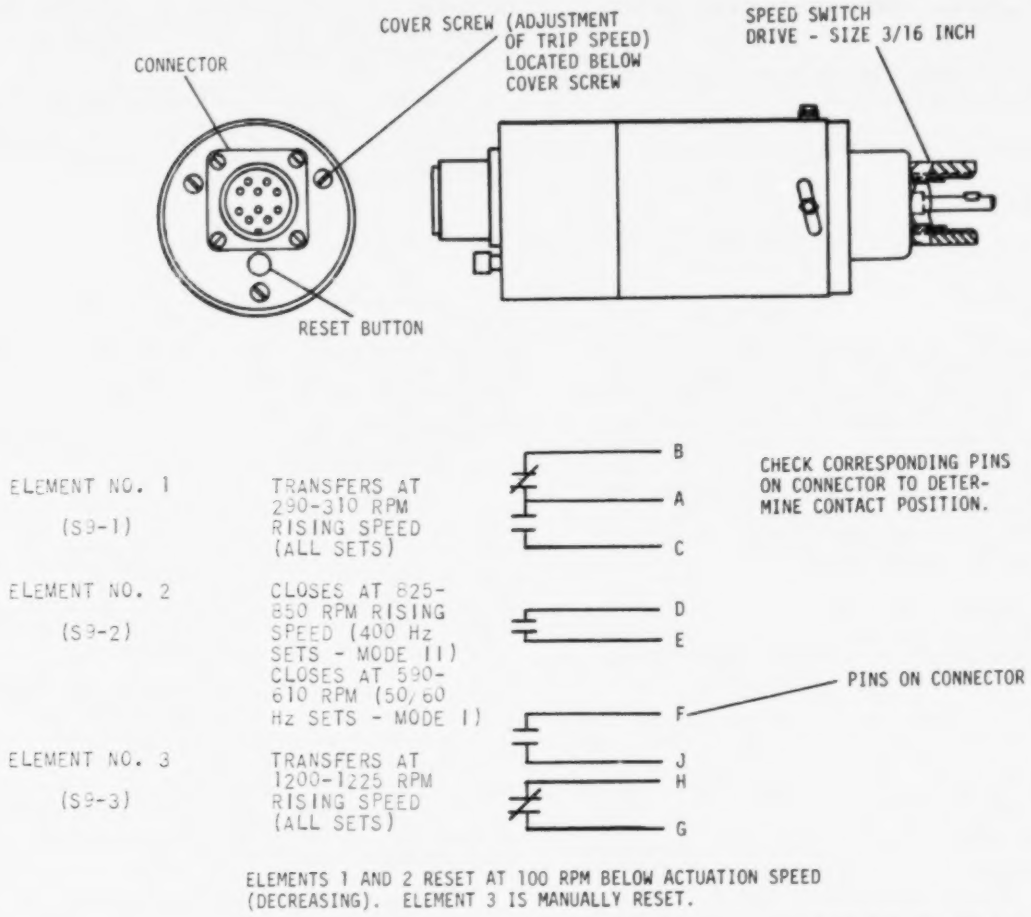
e. Connect ohmmeter leads across pins D and E and verify an open circuit. Increase drive speed and observe that element S9-2 (contacts D and E) closes in the speed range of 590 to 610 rpm (Mode I); 825 to 850 rpm (Mode II). Gradually reduce speed to 490 minimum rpm (Mode I); 725 minimum rpm (Mode II). Observe that element S9-2 resets to the condition shown in figure 14-6.

f. Connect ohmmeter across pins H and G connector and verify a closed circuit. Increase drive speed gradually. The contacts should open at a speed of 1200 to 1225 rpm. Hold drive speed and read contacts F and J. Meter should indicate a closed circuit. Reduce drive speed to less than 1000 rpm, press the manual reset switch and observe with the meter that element S9-3 contacts reset to the condition shown in figure 14-6.

g. To obtain the required performance characteristics during tests c through f adjustments can be made. By loosening screws (1, figure 14-7) and rotating the cap and cover assembly relative to the body assembly, the trip points of all those elements can be raised or lowered. In addition, the trip speed of each individual element can be raised or lowered by removing cover screws as shown in figure 14-6 and turning appropriate set screw located beneath cover screws with a 1/16 inch allen wrench.

NOTE

No adjustments required for Speed Switch (figure 14-7A) used on Serial Numbers FZ-01299 on, for 50/60 Hz and Serial Numbers FZ-06399 on, for 400 Hz.


COVER SCREW (ADJUSTMENT OF TRIP SPEED) LOCATED BELOW COVER SCREW
SPEED SWITCH DRIVE - SIZE 3/16 INCH
CONNECTOR
RESET BUTTON
ELEMENT NO. 1
(S9-1)
TRANSFERS AT 290-310 RPM RISING SPEED (ALL SETS)
B
A
C
CHECK CORRESPONDING PINS ON CONNECTOR TO DETERMINE CONTACT POSITION.
ELEMENT NO. 2
(S9-2)
CLOSES AT 825-850 RPM RISING SPEED (400 Hz SETS - MODE II) CLOSES AT 590-610 RPM (50/60 Hz SETS - MODE I)
D
E
PINS ON CONNECTOR
F
ELEMENT NO. 3
(S9-3)
TRANSFERS AT 1200-1225 RPM RISING SPEED (ALL SETS)
J
H
G
ELEMENTS 1 AND 2 RESET AT 100 RPM BELOW ACTUATION SPEED (DECREASING). ELEMENT 3 IS MANUALLY RESET.

ME 6115-545-34/14-6 C1

Figure 14-6. Speed Switch Sensitivity Tests

14-20. Speed Switch Disassembly.

Refer to figure 14-7 cut safety wire and disassemble in sequence of index numbers observing the following:

a. If either the rotor assembly, the body assembly or the spacer are damaged or defective, replace defective part. Reassembly is the reverse order of disassembly. Refasten with lockwire after readjustment.

b. Repeat the test and adjustment procedures in paragraph 14 - 19.

c. Refer to Operator and Organizational Maintenance Manual and install speed switch.

14-21. Tachometer Drive and Adapter Removal and Disassembly.

See figure 14-8 and proceed as follows:

a. Adapter.

Uncouple adapter from tachometer drive.

b. Tachometer drive.

Remove screw and clamp. Lift tachometer drive up and out of engine housing.

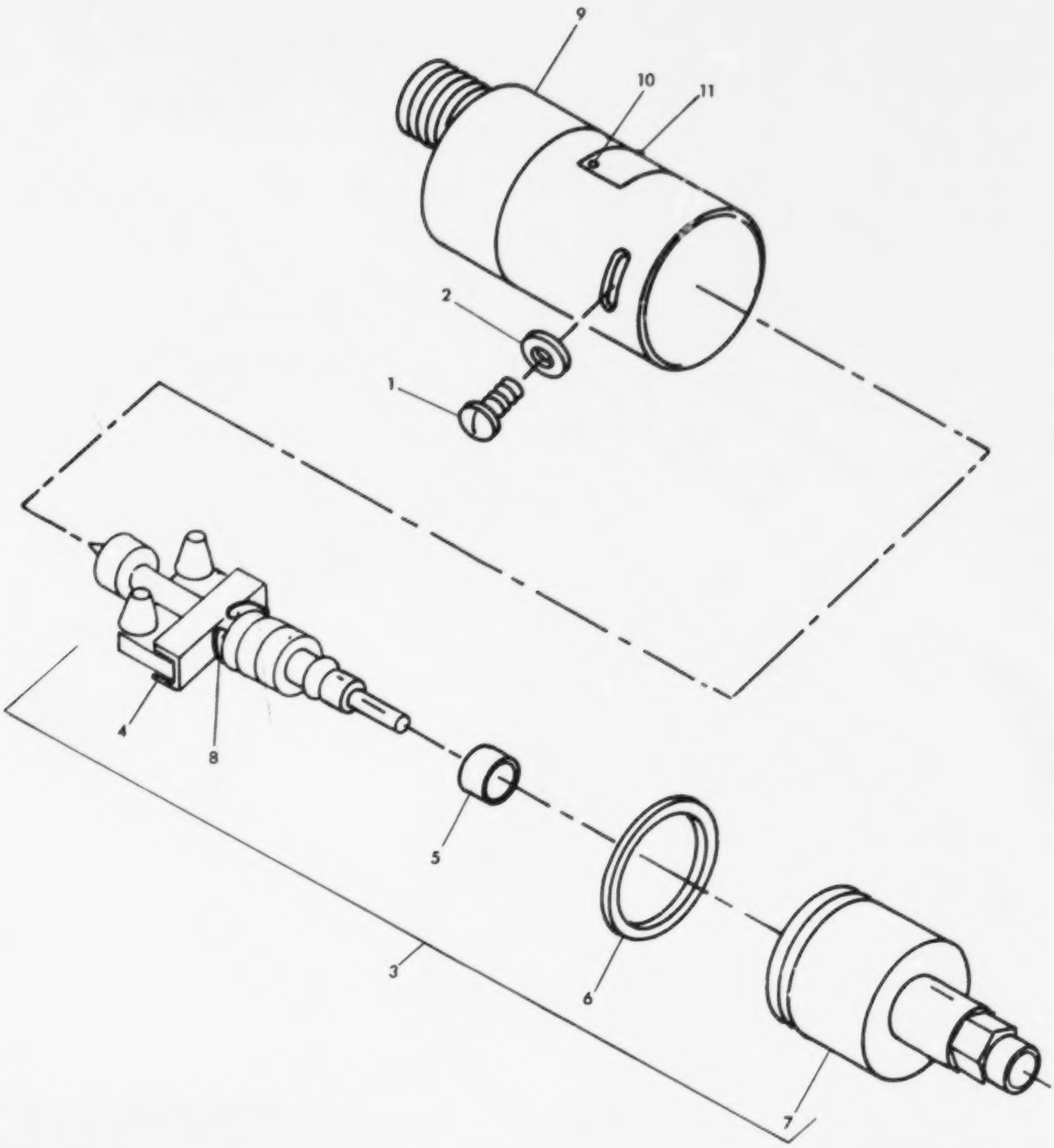
c. Disassemble tachometer drive:

(1) By means of a gear puller, remove gear from shaft.

(2) Remove shaft from top of housing.

(3) Remove preformed packing.

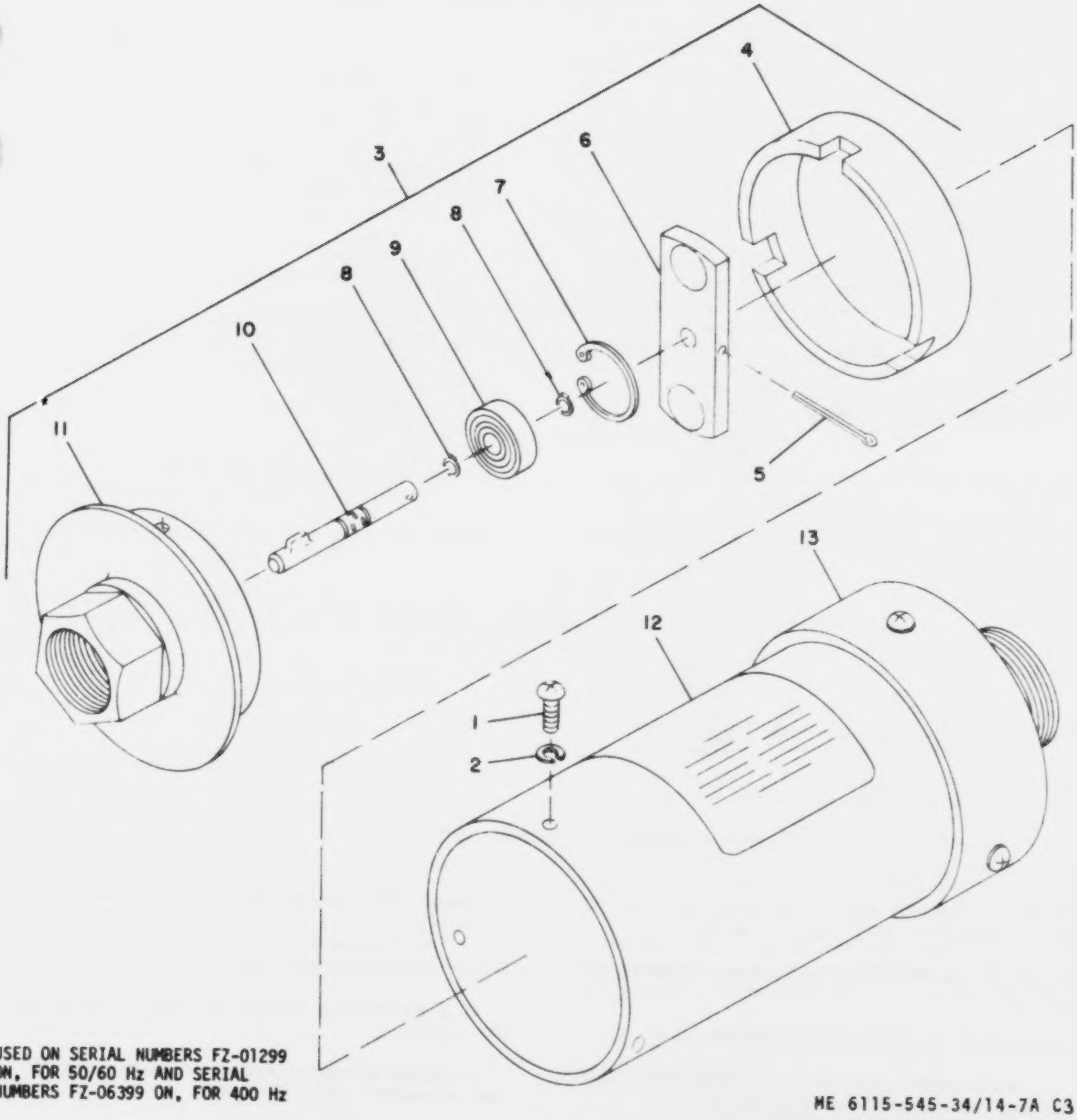
14-22. Tachometer Drive and Adapter Inspection and Repair.



1. Screw
2. Washer
3. Rotor assembly
4. Counter weight
5. Spacer
6. Packing
7. Body assembly
8. Retaining ring
9. Cap and cover assembly
10. Screw
11. Plate

ME 6115-545-34/14-7

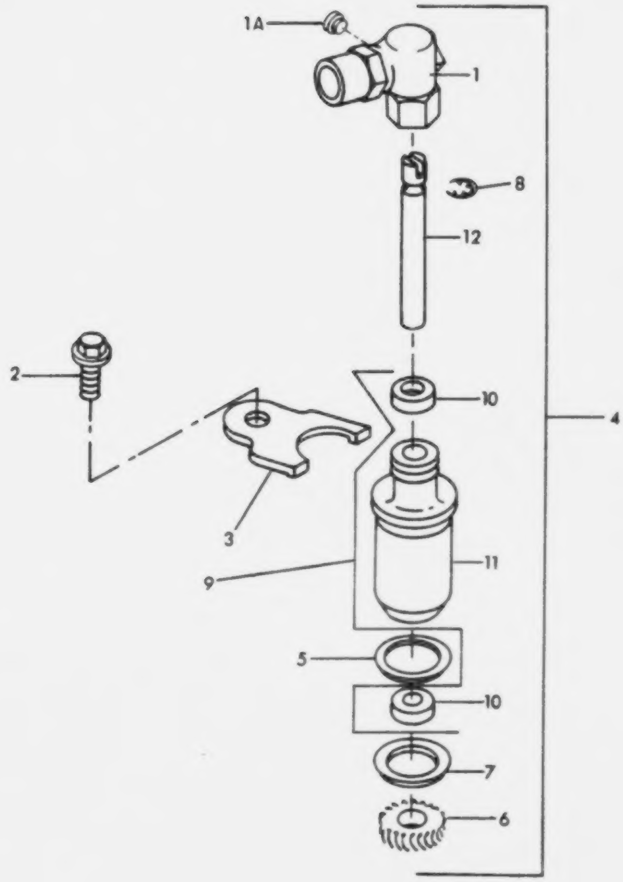
Figure 14-7. Speed Switch



3
4
6
7
8
9
8
10
11
5
13
12
1
2
USED ON SERIAL NUMBERS FZ-01299 ON, FOR 50/60 Hz AND SERIAL NUMBERS FZ-06399 ON, FOR 400 Hz
ME 6115-545-34/14-7A C3

1. Screw
2. Lock Washer
3. Base Assembly
4. Rotor Cap
5. Cotter Pin
6. Rotor
7. Retaining Ring
8. Retaining Ring
9. Bearing
10. Keyed Shaft
11. Base
12. Label
13. Electronics Assembly

Figure 14-7A. Speed Switch



1. Adapter
1A. Plug
2. Screw
3. Clamp
4. Drive assy
5. Preformed packing
6. Gear
7. Thrust washer
8. Retaining ring
9. Housing assy
10. Bushing
11. Housing
12. Shaft

ME 6115-545-34/14-8 C1

Figure 14-8. Tachometer Drive

Inspect all parts for signs of chipping, cracking, and/or excessive wear. Replace as required.

14-23. Tachometer Drive and Adapter Reassembly and Installation.

See figure 14-8 and proceed as follows:

a. Reassemble shaft, retaining ring, retaining bushing, bushing and housing as shown.

b. Reassemble bushing and thrust washer by means of a small press. Refit gear to shaft.

c. Coat housing and preformed packing with film of light engine oil. Refit preformed packing.

d. Hold tachometer drive vertical and insert down into engine.

e. Install clamp (tightening action of screw will seat tachometer drive in engine).

f. Refer to Operator and Organizational Maintenance Manual and install speed switch.

## Section V. ELECTRIC STARTER

### 4-24. General.

The engine generator set is equipped with a 24-volt shift lever type electric starter. It is mounted directly to the flywheel housing at the engine's right ear and is connected to the batteries by a solenoid witch. It rotates clockwise as viewed from the rive end. Battery voltage is supplied to engergize the starter solenoid which engergizes the electric starter to crank the engine.

### 14-25. Starter Removal and Disassembly.

a. See figure 14-9 and proceeds as follows. Remove starting motor. Refer to Operator and Organizational Maintenance Manual as follows.

(1) Disconnect the negative cable from the battery.

(2) Tag and disconnect battery cables and electrical wires from starter (3, fig. 14-9).

(3) Remove tool box to gain access to starter screws (1).

(4) Remove three 12-point screws (1) and three washers (2). Remove starter (3) and starter adapter (4).

NOTE

Check ring gear to assure that teeth are not damaged.

b. Installation. Install the starter (3, fig. 14-9) on the flywheel housing in reverse order of removal.

### 14-26. Brushes Inspection and Replacement.

To inspect and replace the starter motor brushes, proceed as follows:

a. Gain access to the starter motor as in paragraph 14-25.

b. Remove the starter commutator end head assembly, (11) (fig. 14-10) as follows:

(1) Scribe a mark on end head (11) and frame to cate relative position at assembly.

(2) Remove lead assembly (3, fig. 14-10) by removing nut (1), washer (2) and nut (4), lockwasher (5), flat washer (6), phenolic washer (7), flat washer (8), and rubber washer (9).

(3) Remove seven bolts (10).

(4) Remove commutator end head assembly (11), gasket (12), and washer (13).

(5) Remove insulator (14) and insulating bushing (15).

c. Remove four brush springs (21) by lifting end of spring from slot and sliding spring from mounting arm. Remove four brushes (22) from brush plate (18).

(1) Tag and disconnect electrical leads from brushes (22) by removing screw (19) and washer (20).

(2) Measure the length of each brush. If any brush is less than 3/8 inch long, replace the complete set of brushes with new brushes.

d. Install the brushes as follows:

(1) Clean all brushes with a clean, dry cloth only. Do not permit dry cleaning solvent to come in contact with the brushes.

(2) Install brushes in reverse order of removal.

e. See figure 14-10 and install the commutator end head (11) in reverse order of removal.

### 14-27. Starter Solenoid.

To replace the starter solenoid (29, fig. 14-10) proceed as follows:

a. Removal.

(1) Disconnect electrical connections to solenoid.

(2) Remove screws (26, fig. 14-10).

(3) Remove plug (23) and gasket (24).

(4) Slide solenoid (29) toward brush end of motor.

(5) Slip back rubber boot and insert screwdriver in slot of solenoid core to prevent core from rotating while removing nut (25).

(6) Remove solenoid (29).

b. Installation.

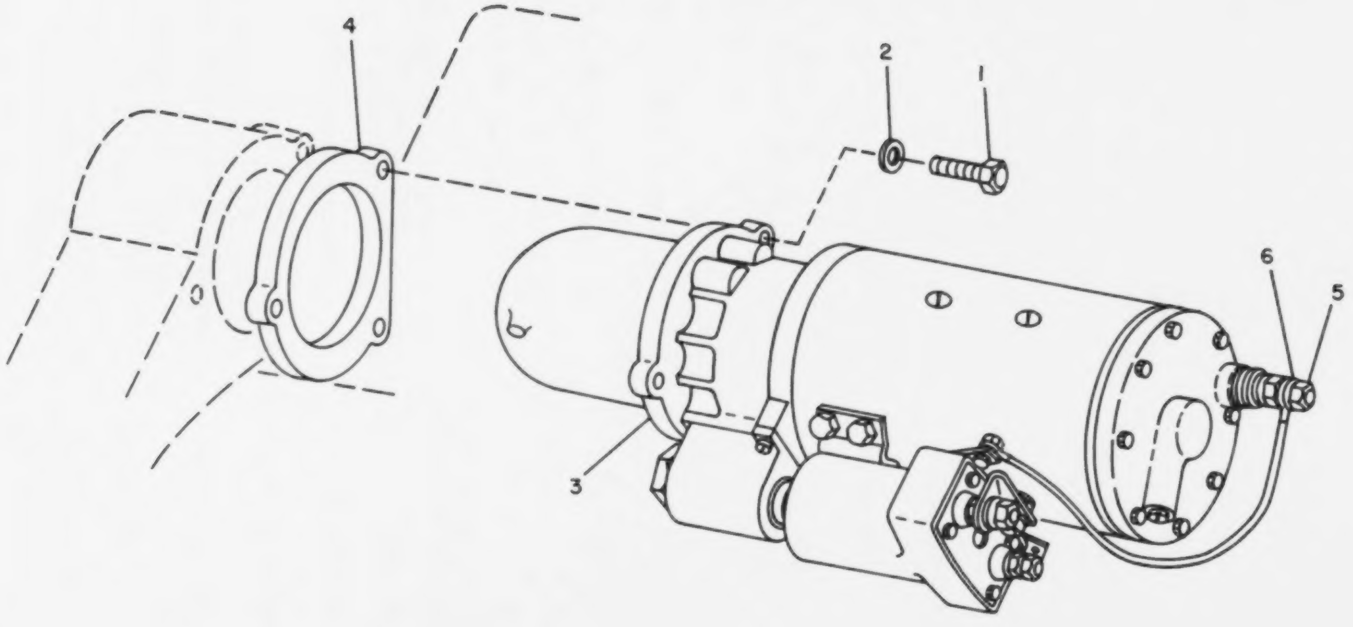
(1) Install starter solenoid in reverse order of removal and perform steps (2) and (3) below.

(2) Place starter on bench and apply 24 Vdc to the starter solenoid terminals.

(3) With 24 Vdc applied to starter solenoid terminals, the starter drive pinion should be observed moving forward and spinning.

c. Disassembly. Disassemble as illustrated in figures 14-11 through 14-13.

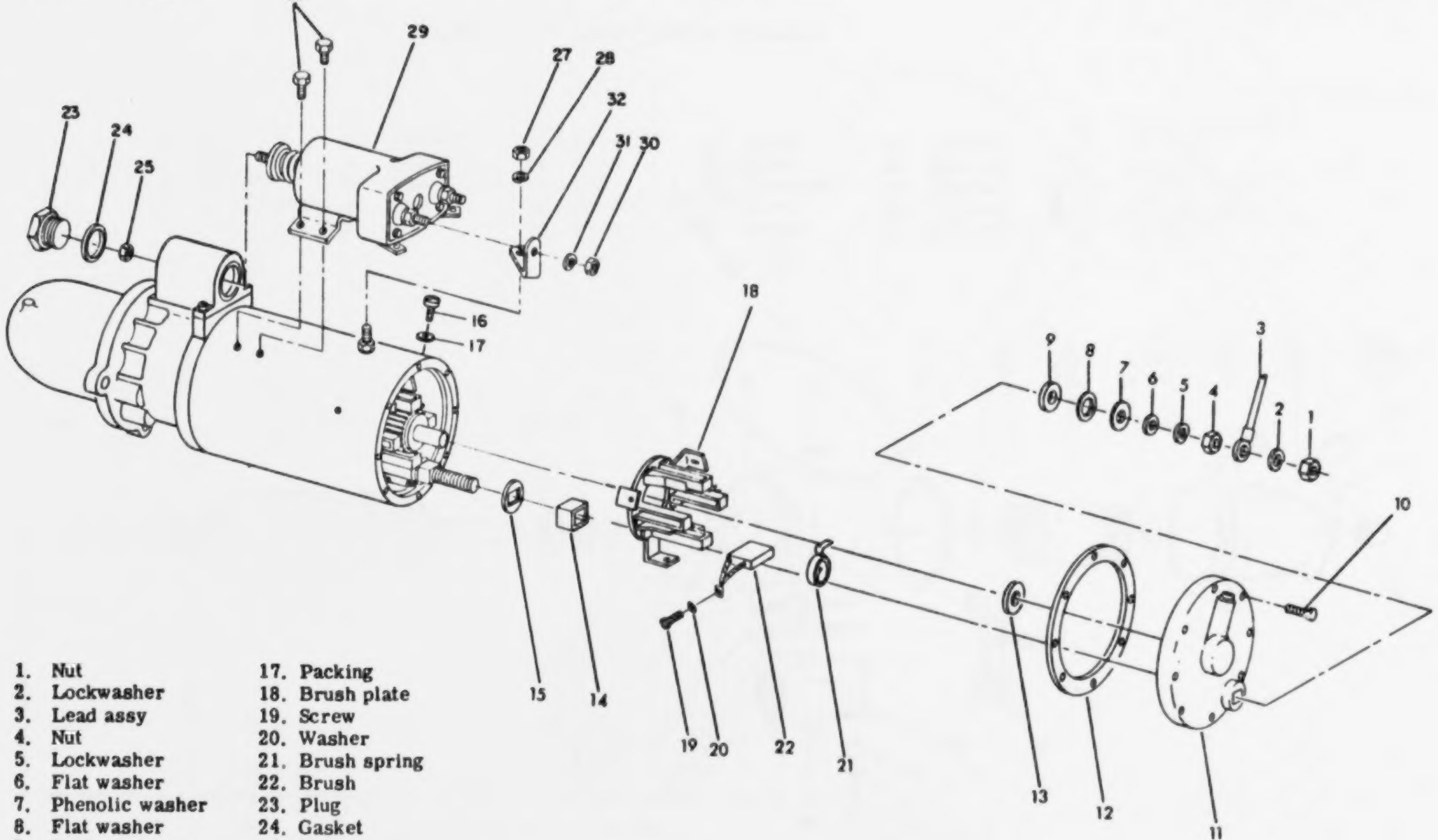
(1) Refer to figure 14-11 and disassemble major subassemblies as follows:



ME 6115-545-34/14-9 C4

1. Screw (12 point)
2. Washer
3. Starter
4. Adapter
5. Nut
6. Washer

Figure 14-9. Electrical Starter Removal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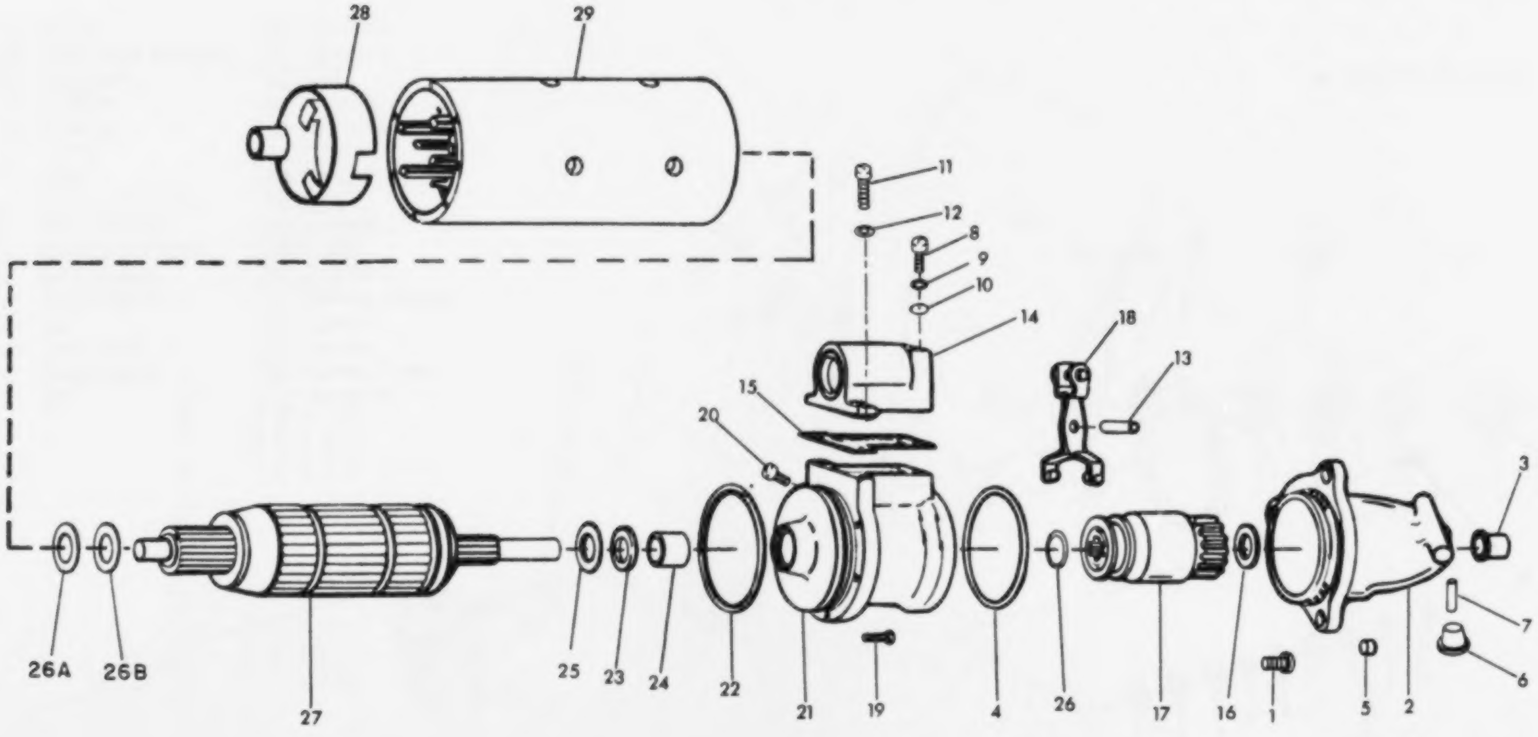
15
14
19
20
22
21
13
12
11
ME 6115-545-34/14-10

1. Nut
2. Lockwasher
3. Lead assy
4. Nut
5. Lockwasher
6. Flat washer
7. Phenolic washer
8. Flat washer
9. Rubber washer
10. Bolt
11. Head
12. Gasket
13. Washer
14. Insulator
15. Insulating bushing
16. Screw
17. Packing
18. Brush plate
19. Screw
20. Washer
21. Brush spring
22. Brush
23. Plug
24. Gasket
25. Nut
26. Screw
27. Nut
28. Washer
29. Solenoid
30. Nut
31. Washer
32. Bracket

Figure 14-10. Electrical Starter Brush and Solenoid Assembly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3
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6
26A
26B
27
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23
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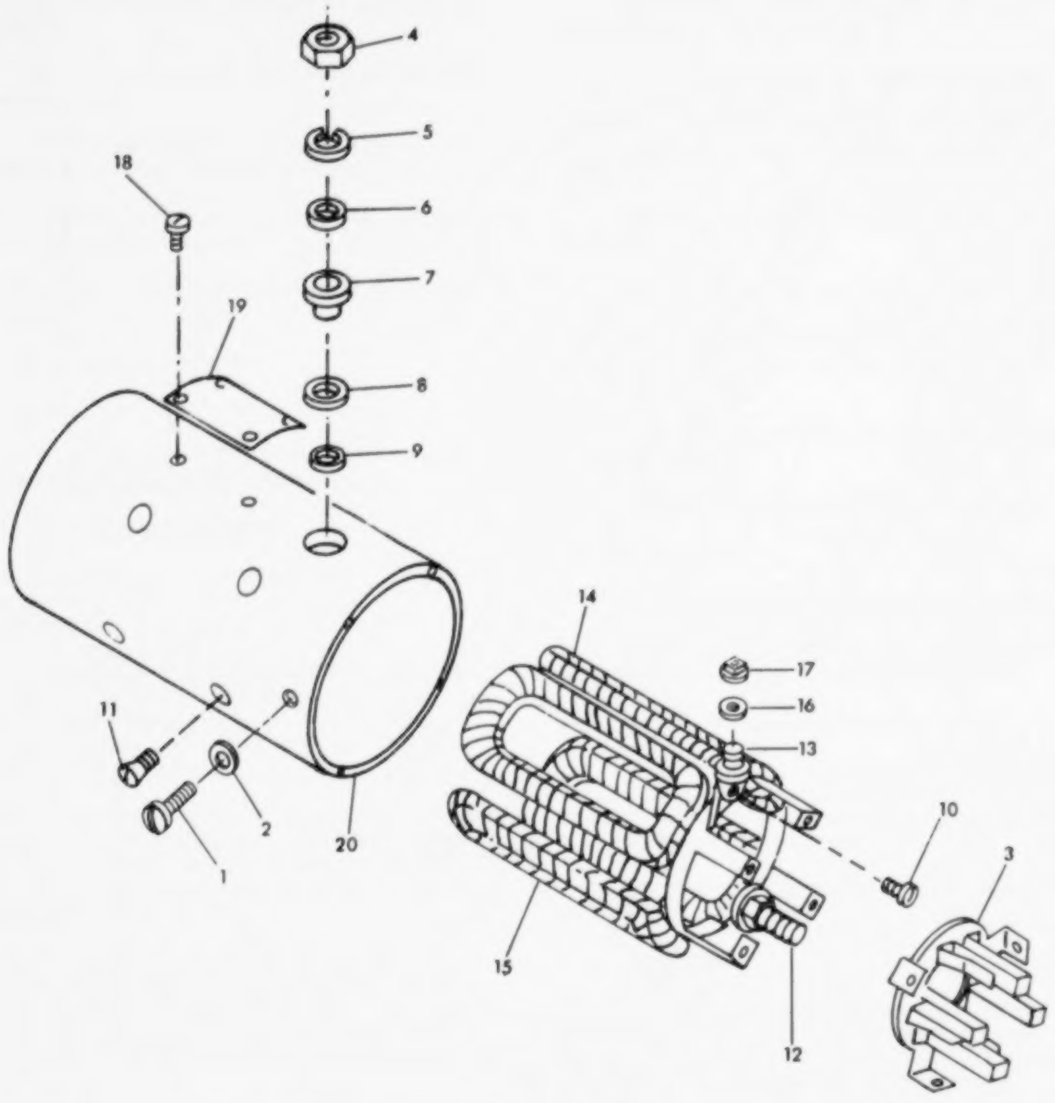
22
21
19
4
26
17
16
1
5
2

1. Screw
2. Housing assy
3. Bearing
4. Seal
5. Plug
6. Plug
7. Wick
8. Screw
9. Washer
10. Packing
11. Screw
12. Washer
13. Pin
14. Cover
15. Gasket
16. Washer
17. Drive
18. Yoke assy
19. Screw
20. Screw
21. Housing
22. Packing
23. Packing
24. Bearing
25. Washer
26. Washer
26A. Thrust washer
26B. Thrust washer
27. Armature
28. Insulator
29. Frame-field assy

ME 6115-545-34/14-11 C4

Figure 14-11. Electric Starter Assembly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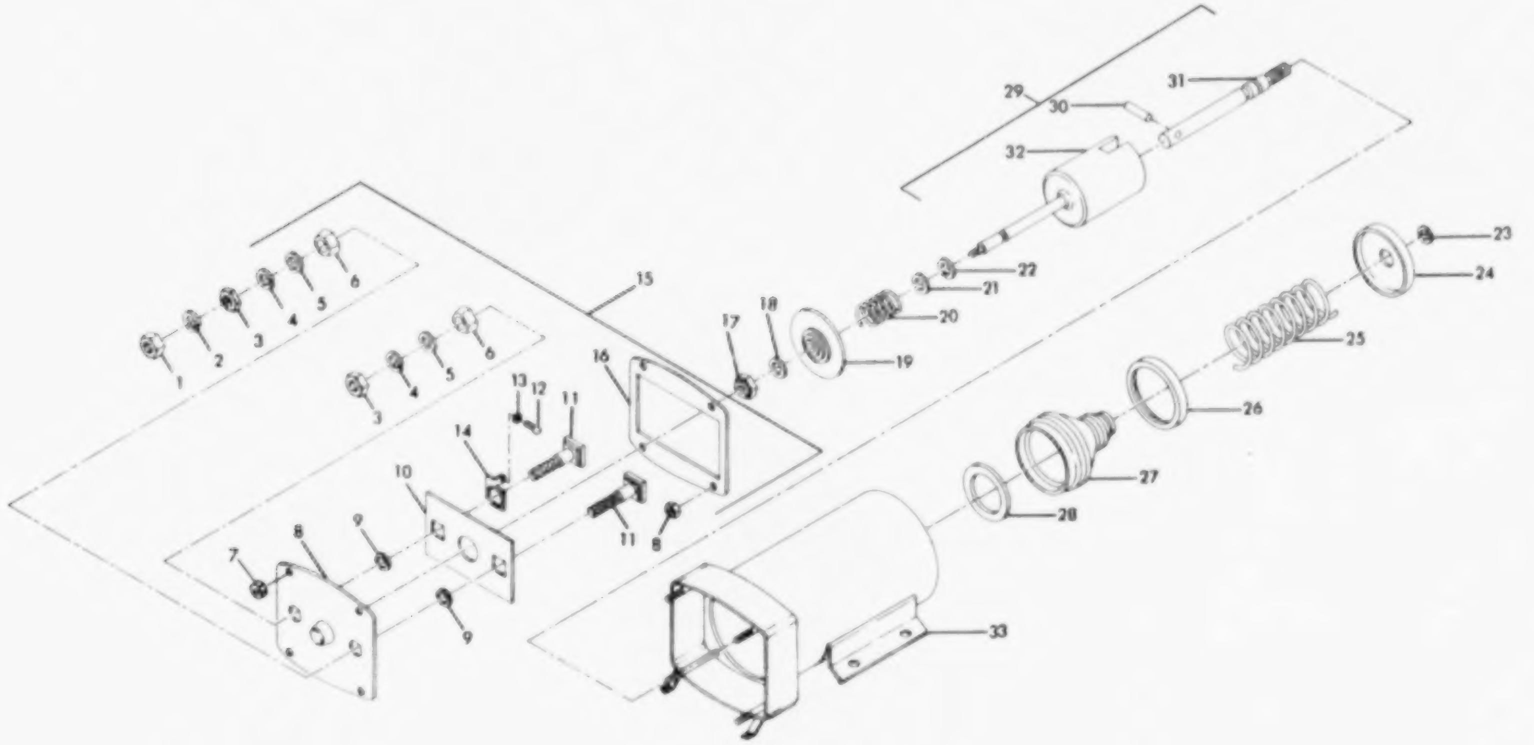
2
20
1
3
15
12

1. Screw
2. Washer
3. Plate assy
4. Nut
5. Washer
6. Washer
7. Washer
8. Washer
9. Washer
10. Screw
11. Screw
12. Screw
13. Screw
14. Coil
15. Coil
16. Washer
17. Bushing
18. Screw
19. Plate
20. Housing

ME 6115-545-34/14-12

Figure 14-12. Frame and Field Assembly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19
16
13
12
11
14
10
11
8
7
8
9
9
25
26
27
28
33

1. Nut
2. Lockwasher
3. Nut
4. Washer
5. Washer
6. Bushing
7. Nut
8. Cover
9. Bushing
10. Insulator
11. Stud
12. Screw
13. Washer
14. Lug
15. Cover & Contact Assy
16. Gasket
17. Nut
18. Washer
19. Contact
20. Spring
21. Washer
22. Retainer
23. Ring
24. Retainer
25. Spring
26. Retainer
27. Boot
28. Washer
29. Core assy
30. Pin
31. Shaft
32. Core
33. Case

ME 6115-545-34/14-13

Figure 14-13. Solenoid Assembly

(a) Remove item 1 through 12 as shown on figure 14-11.

(b) Lift packing (23) and knock out pin (13). Remove cover (14).

(c) Disassemble the remaining parts in accordance with index numbers 16 through 29.

(2) Disassemble frame and field coil assembly as illustrated in figure 14-12.

(3) Disassemble solenoid assembly as illustrated in figure 14-13.

### 14-28. Cleaning and Inspection.

a. Cleaning.

(1) Blow out all dirt from inside field frame and wipe interior with a clean cloth.

CAUTION

Do not submerge armature, field coils, solenoid or clutch drive in solvent.

(2) Clean field coils and frame thoroughly with a cloth dampened with cleaning solvent Federal Specification P-D-680. Be careful not to damage protective insulation and fungus coating. Dry thoroughly with compressed air.

(3) Remove loose particles from armature with compressed air and wipe with a clean cloth dampened with cleaning solvent. Clean commutator lightly with No. 00 sandpaper and remove all traces of dust with low-pressure compressed air.

(4) Clean brush holders and springs with a brush and cleaning solvent, Federal Specification P-D-680, and dry them thoroughly with compressed air. Clean insulation and plate with a clean cloth dampened with cleaning solvent and dry with compressed air.

(5) Clean solenoid relay assembly parts with a clean cloth dampened with cleaning solvent, Federal Specification P-D-680, and dry with low-pressure compressed air.

(6) Clean brushes with a clean, dry cloth only. Do not permit cleaning solvent to come in contact with the brushes.

b. Inspection and Tests.

(1) Inspect drive assembly drive pinion for broken, chipped, or badly worn teeth. Replace drive assembly if defective.

(2) Inspect internal splines in drive assembly shell and pinion for cracked, chipped, or broken condition. Replace drive assembly if defective.

(3) Inspect all drive assembly splines and pinion teeth for nicks and burrs.

(4) Test field coils for insulation breakdown with megger connected between frame and one coil terminal. Minimum resistance reading permissible is one megohm. Replace starter assembly if coil is defective.

(5) Inspect coil terminal lugs for damaged threads.

(6) Test armature for grounds with a test light. Touch a test light probe to the armature core and the other probe to a commutator bar riser. If test light glows, armature is grounded. Repeat test for all commutator bars.

(7) Test armature for short circuits using a growler.

(8) Check brushes for excessive wear.

### 14-29. Repair.

a. Pinion Housing and Commutator End Head.

(1) Smooth minor scratches, burrs, and dents on machined surfaces using a fine mill file.

(2) Repair damaged threads.

(3) Smooth minor rough spots, score marks, and scratches from inside bore of bronze bearing using a fine stone or crocus cloth dipped in cleaning solvent, Federal Specification P-D-680.

b. Brush Holder Assembly. Replace a defective brush holder assembly.

c. Armature.

(1) Resurface commutator removing no more than 0.005 inch during any one cut and no more than 0.002 inch on final cut. Check that final diameter of commutator is not less than 1.6470 inches.

(2) If commutator diameter is satisfactory, undercut mica to a depth of 0.025 to 0.032 inch below commutator surface.

NOTE

Use care in undercutting. Do not widen commutator slots by removing metal from segments, and do not leave thin edge of mica next to segment.

(3) After the mica has been undercut, remove all copper and mica particles with compressed air. Polish the commutator in a lathe with number 2/0 sandpaper while the armature is rotating at 1500 rpm. After polishing the armature, check that commutator diameter is not less than 1.6470 inches. Replace if diameter is less.

d. Drive Assembly.

(1) Smooth burrs, nicks and rough spots on splines and pinion teeth using a fine stone or crocus cloth dipped in cleaning solvent, Federal Specification P-D-680.

(2) Smooth rough spots, scoring, scratches and nicks on inside bore of sleeve bearings and all surfaces of bronze bearings using crocus cloth dipped in cleaning solvent, Federal Specification P-D-680.

e. Solenoid Assembly Repair.

(1) Check relay windings for shorts or grounds with ohmmeter. Replace relay if windings are defective.

(2) Replace relay if contact assembly shows defects such as warpage, cracks, or broken springs.

(3) Minor burns or pits on contact surfaces are permissible. If conditions are severe, replace relay. Do not use a file to dress severely burned or pitted contact surfaces.

f. Field Coil Assembly.

(1) Smooth minor scratches, burrs, and nicks on machined surfaces of frame using fine mill file.

(2) Repair damaged threads in frame. Repair damaged threads on field coil terminal stud.

(3) Replace starter assembly if field coil insulation resistance is less than one megohm.

### 14-30. Reassembly and Adjustments.

a. Reassembly. Reassemble electric starter in reverse order of disassembly. See figures 14-11 through 14-13.

b. Adjustments. Perform the following adjustments during reassembly.

(1) Solenoid relay plunger shaft.

(a) See figure 14-14. Connect 12 Vdc across relay terminals A and B. Using a jumper, momentarily connect lead terminal C to terminal A to pull the relay plunger into the sealed position. Place a straight edge across the relay case as shown. Measure the distance from the shaft shoulder to the straight edge. This dimension should be 7/32 inch maximum for proper assembly, and the self-locking nut will be tight after assembly. Disconnect power from terminals A and B.

(b) If the shoulder to straight edge dimension exceeds 7/32-inch, the self-locking nut must be installed and tightened until the end of the nut and the end of the shaft are flush as illustrated in figure 14-14. This procedure will provide adequate overtravel.

(2) Drive assembly pinion clearance.

(a) See figure 14-15 for adjustments.

(b) Remove motor field coil connector from the motor switch terminal stud.

(c) Remove ground lead assembly connecting motor solenoid relay terminal and starter ground terminal stud.

(d) Remove solenoid relay lead assembly connecting battery switch terminal stud and battery solenoid relay terminal.

(e) Connect a 24-volt battery supply to battery solenoid relay terminal and motor solenoid relay terminal.

(f) Momentarily hold a jumper lead from the motor switch terminal stud to the motor solenoid relay terminal. The pinion will now shift into cranking position and remain so until the battery is disconnected.

(g) Push pinion back toward armature to take up slack movement.

(h) Check for 0.020- to 0.050-inch clearance between thrust washer and pinion. To adjust, remove inspection plug and gasket. Adjust clearance to 0.020 to 0.050 inch by turning shaft nut as shown in figure 14-15.

(i) Connect a test light or other continuity checker between the battery switch terminal and motor switch terminal stud.

(j) Connect one of the posts of a 24-volt battery to the battery solenoid relay terminal. Connect the other battery post to the motor solenoid relay terminal.

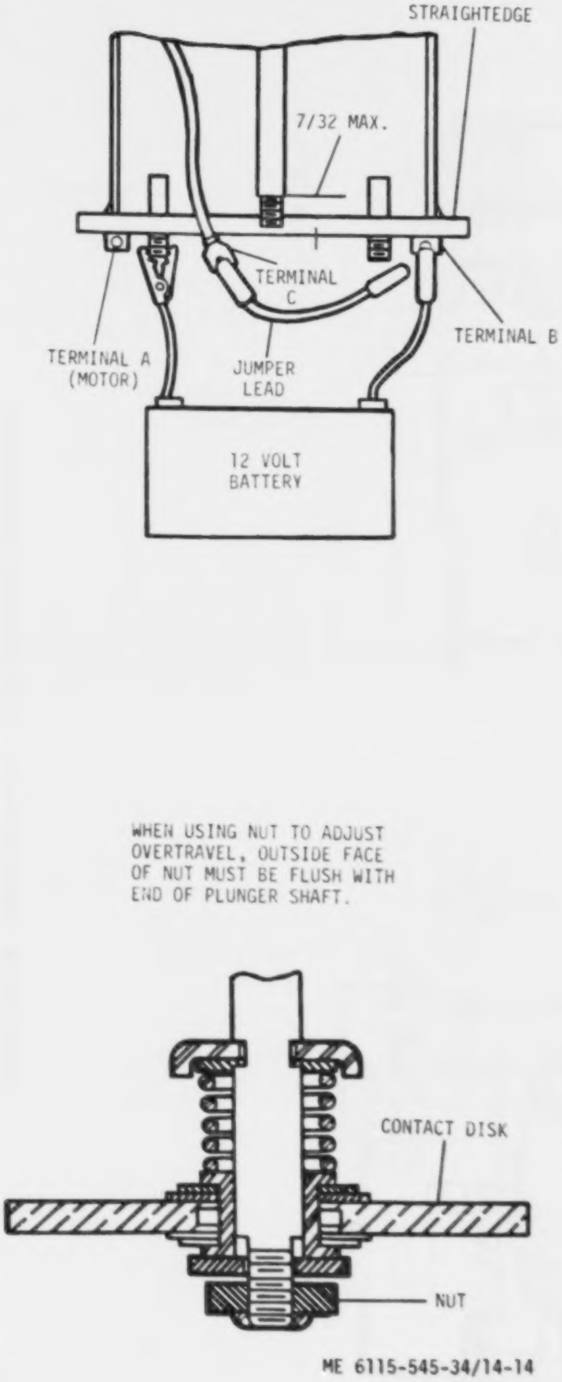
(k) Place a 0.983-inch spacer block (figure 14-15) between the pinion and thrust washer and momentarily hold a jumper lead from the motor switch terminal stud to the motor solenoid relay terminal. The pinion will now shift against the spacer block and remain so until the jumper lead is disconnected. The motor must not run. The motor must run when the distance between the pinion and thrust washers is 0.500 inch.

(l) An open circuit should be indicated between the battery switch and motor switch terminals. If continuity exists, decrease the pinion clearance ((a) above) to the minimum limit of 0.020 inch and recheck to make sure an open circuit now exists.

(m) Disconnect battery and test equipment and install motor field connector, ground lead and solenoid relay lead.

(n) Install inspection plug and gasket.

### 14-31. Test and Installation.



WHEN USING NUT TO ADJUST OVERTRAVEL, OUTSIDE FACE OF NUT MUST BE FLUSH WITH END OF PLUNGER SHAFT.

ME 6115-545-34/14-14

Figure 14-14. Solenoid Adjustments

a. See figure 14-16 and connect the electric starter in the no-load test circuit illustrated. Perform no-load test as follows:

(1) Energize the test circuit and obtain a voltage of 22 volts by varying the variable resistance.

(2) Check the speed of the armature on the tachometer. Minimum speed should be 7000 rpm.

(3) Check the current draw on the ammeter. Maximum current draw should be 90 amperes. If a low-speed, high-current condition exists, possible causes are excessive armature arcing, armature ground, armature short, or armature drag caused by loose pole shoes or faulty bearings. A low-speed, low-current condition indicates faulty brushes or faulty connection.

b. See figure 14-16 and set up for lock torque test as illustrated.

CAUTION

Never operate the electric starter with all resistance removed from the circuit. Failure to adhere to this caution will result in extreme motor speeds which can cause damage to the motor and possible injury to personnel.

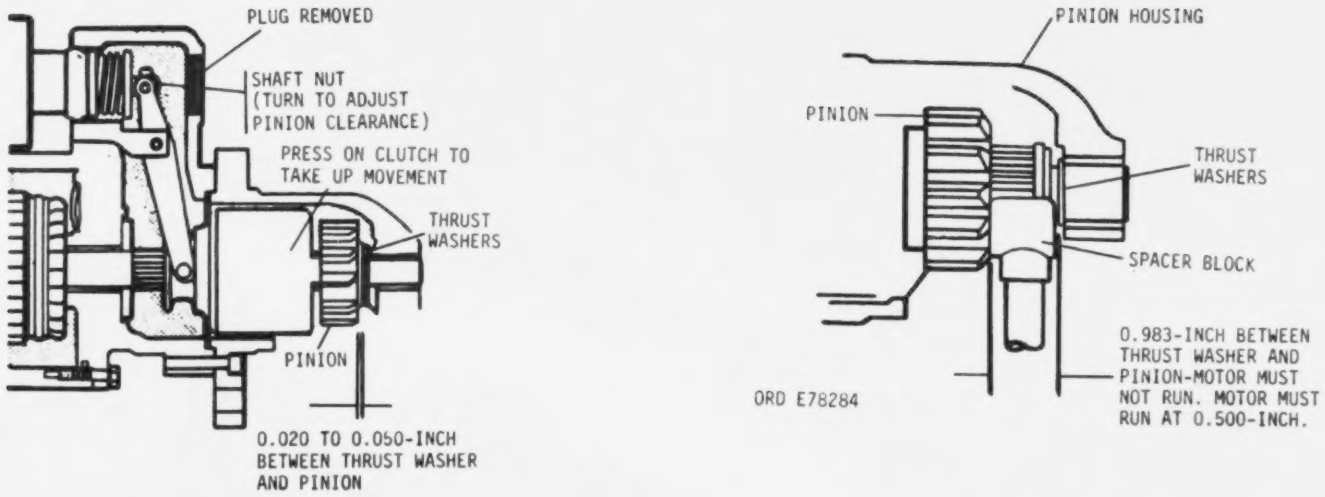
NOTE

The variable resistance should be one with a high current capacity.

(1) Energize the circuit and check the scale to determine the torque output of the motor.

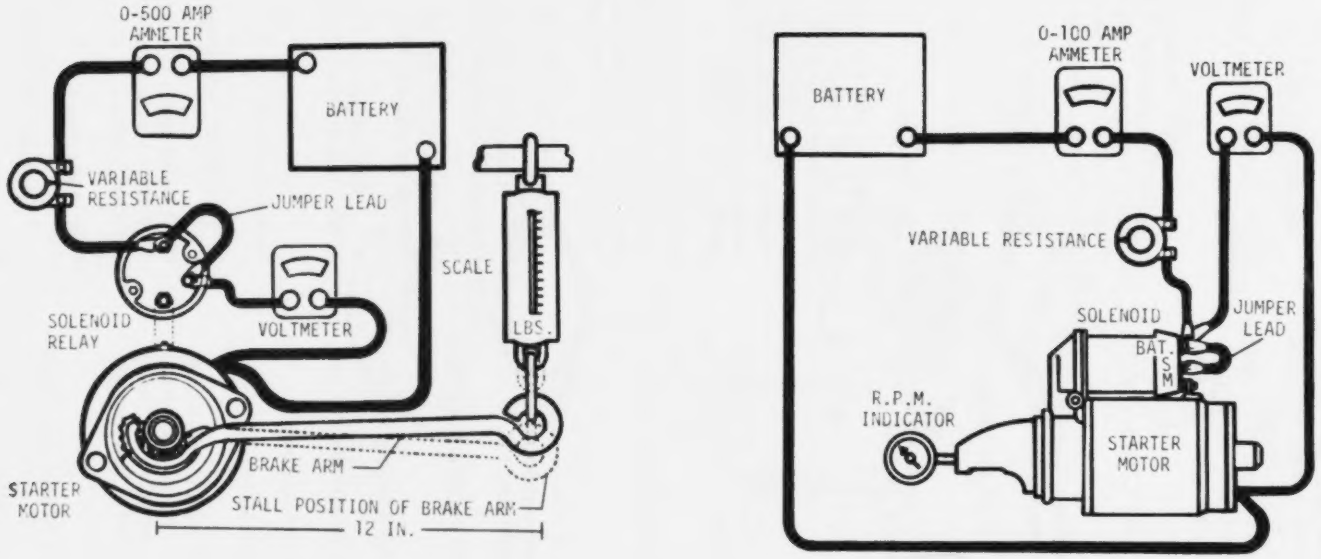
(2) Scale should indicate 22 pound-feet (minimum), at 400 amperes and approximately four volts, as indicated on the meters.

c. Installation. Install the starter motor on the flywheel housing using the disassembly steps in reverse order. See figure 14-9.


PLUG REMOVED
SHAFT NUT (TURN TO ADJUST PINION CLEARANCE)
PRESS ON CLUTCH TO TAKE UP MOVEMENT
THRUST WASHERS
PINION
0.020 TO 0.050-INCH BETWEEN THRUST WASHER AND PINION
PINION HOUSING
PINION
THRUST WASHERS
SPACER BLOCK
0.983-INCH BETWEEN THRUST WASHER AND PINION-MOTOR MUST NOT RUN. MOTOR MUST RUN AT 0.500-INCH.
ORD E78284

ME 6115-545-34/14-15

Figure 14-15. Drive Assembly Pinion, Clearance Adjustments


0-500 AMP
AMMETER
BATTERY
VARIABLE
RESISTANCE
JUMPER LEAD
SCALE
SOLENOID
RELAY
VOLTMETER
LBS.
BRAKE ARM
STARTER
MOTOR
STALL POSITION OF BRAKE ARM
12 IN.
BATTERY
0-100 AMP
AMMETER
VOLTMETER
VARIABLE RESISTANCE
SOLENOID
JUMPER
LEAD
BAT.
S
M
R.P.M.
INDICATOR
STARTER
MOTOR

LOCKED ROTOR TORQUE TEST CIRCUIT

NO LOAD TEST CIRCUIT

ME 6115-545-34/14-16

Figure 14-16. Electric Starter, Test Circuits

## Section VI. LUBE OIL COOLER AND FILTER BYPASS VALVE

### 14-32. General.

The lube oil cooler is mounted on the right side of the engine cylinder block and receives coolant from the water pump. Engine lubricating oil is pumped through a chamber in the lube oil cooler. The chamber walls are cooled by the coolant and, in turn, maintain the engine lube oil at a safe operating temperature.

### 14-33. Removal, Disassembly, and Cleaning of Oil Cooler.

a. Removal. Refer to the Operator and Organizational Maintenance Manual for removal procedures.

b. Disassembly. See figure 14-17 and disassemble the lube oil cooler as shown.

c. Cleaning. Clean all metallic parts with cleaning solvent, Federal Specification P-D-680.

### 14-34. Inspection and Repair.

a. Inspection.

(1) Inspect cooler housing, bonnet, and header for cracks, distortion, and scoring of mating surfaces.

(2) Inspect cooler assembly passages for obstructions.

b. Repair.

(1) Clean passages with steam under pressure to insure that there are no obstructions.

(2) Smooth burrs or scoring on mating surfaces with a fine mill file.

(3) Replace any parts damaged beyond repair.

(4) Discard all gaskets and preformed packing.

### 14-35. Test, Reassembly, and Installation.

a. Test.

(1) Make up two plates, one with a drilled and tapped hole to accept an air hose fitting, and secure them with C clamps to cover the oil inlet and outlet openings in the side of the oil cooler. Use the preformed packing to seal the plates.

(2) Attach an air hose to the drilled and tapped plate; submerge the oil cooler in hot water until the oil cooler temperature is up to approximately 150°F. Test for leaks with air pressure of 100 psi.

(3) No air bubbles shall appear at either open end of the lube oil cooler. If the cooling core is faulty, the oil cooler must be replaced. If the shell is damaged it must be replaced.

b. Reassembly.

(1) See figure 14-17 and reassemble the lube oil cooler.

(2) After reassembly, place the lube oil cooler on a surface plate as if it were being mounted. Using a feeler gauge, check to see if all machined surfaces contact the plate within 0.005 inch. Loosen and retighten screws to obtain this clearance.

c. Installation. Refer to the Operator and Organizational Maintenance Manual.

### 14-36. Lube Oil Filter Bypass Valve.

a. General.

The lube oil filter bypass valve is part of the header block of the engine lube oil filter assembly. If the filters become clogged, such that the differential pressure across the combination of both filters rises to 45 psi the bypass valve opens permitting unfiltered oil to bypass the filters and go directly to the main oil gallery.

Cold weather induced thickening of the oil will cause the filters to be bypassed. As the engine oil warms the bypass valve will close inserting the filter elements into the oil stream.

b. Removal. (See figure 14-18)

(1) Both oil filters must be removed. Refer to Operator and Organization Maintenance Manual.

(2) Remove the oil filter header block by removing six cap screws.

(3) Thoroughly clean the area at the rear of the header block where the bypass valve is located.

(4) Remove the cap, gasket, spring, piston sleeve and seat.

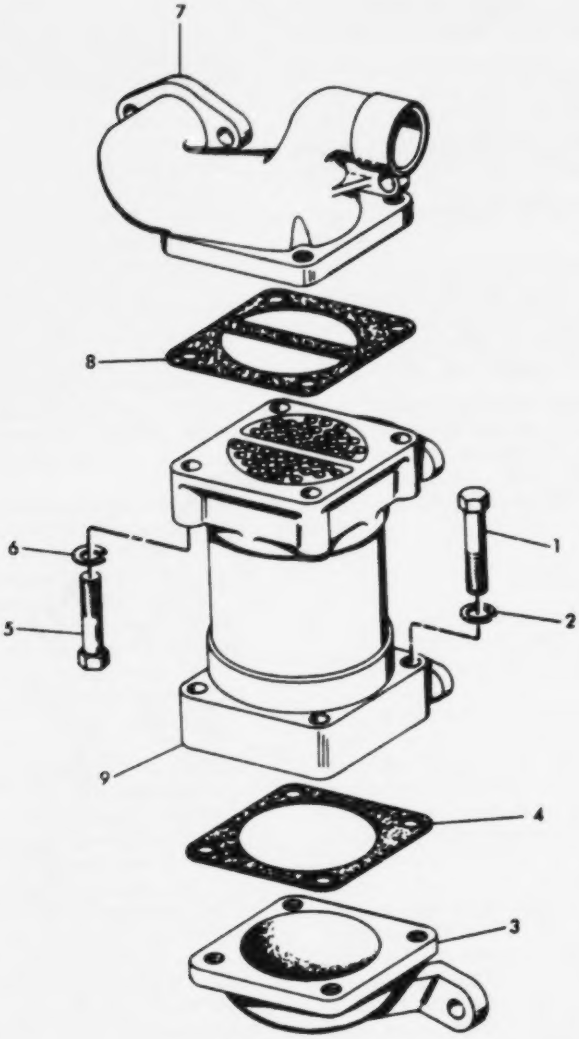
c. Cleaning and Inspection.

Wash valve parts in cleaning solvent. Inspect carefully for wear or damage. Replace any worn or damaged parts.

d. Installation.

(1) Install valve in reverse order of disassembly.

(2) Renew filter header gaskets and lube oil bypass valve gasket.



ME 6115-545-34/14-17

1. Screw
2. Washer
3. Header
4. Gasket
5. Screw
6. Washer
7. Bonnet
8. Gasket
9. Cooler

Figure 14-17. Lube Oil Cooler

(3) Mount filter header to oil gallery with 6 cap screws.

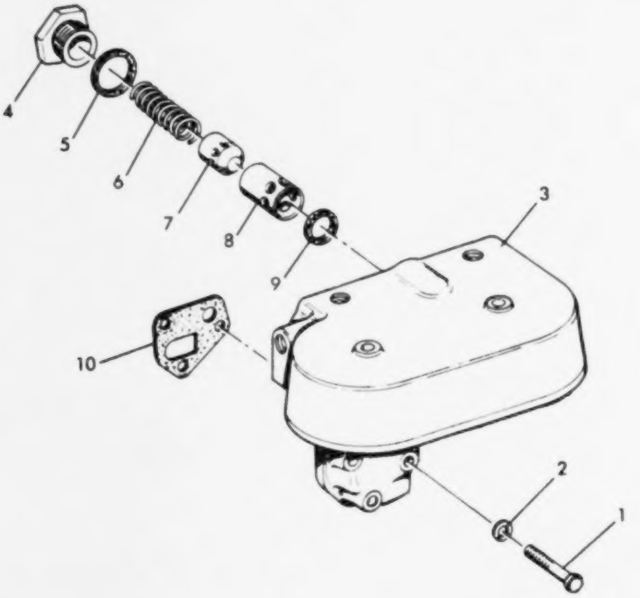
(4) Mount engine lube oil filter to filter header. Refer to Operator and Organizational Maintenance Manual.

e. Test.

(1) Start engine. Refer to Operator and Organizational Maintenance Manual.

(2) Observe the oil pressure gauge located in the control cubicle.

(3) If the oil pressure is abnormally high or low after the engine has warmed, then a failure in the relief valve has occurred.



1. Screw
2. Washer
3. Header assembly
4. Cap
5. Gasket
6. Spring
7. Piston
8. Sleeve
9. Seat
10. Gasket

ME 6115-545-34/14-18

Figure 14-18. Lube Oil Bypass Valve

## Section VII. NOZZLE HOLDER ASSEMBLIES

### 14-37. General.

a. Each engine cylinder is provided with a multi-hole, differential needle, hydraulically lifted, nozzle holder assembly. The function of each nozzle holder assembly is to direct a metered quantity of fuel received from the fuel injection pump into the corresponding engine combustion chamber in a highly atomized, pre-determined spray pattern in such manner as to produce the most efficient performance. Each nozzle holder assembly consists of two assemblies, an injection nozzle holder and an injection nozzle.

b. The holder assembly positions the nozzle in the cylinder head and provides a means of conducting fuel received from the fuel injection pump to the nozzle. The holder consists of a steel holder body, two locating dowels, spindle, spindle spring, pressure adjusting screw, adjusting screw locknut, gaskets, cap nut, and a nozzle retaining nut.

c. The nozzle assembly consists of a nozzle valve and a nozzle body in which are located four spray orifices equally spaced 90 degrees apart. The nozzle valve is operated hydraulically within the valve body by fuel delivered under pressure by the fuel injection pump. The nozzle is positioned on the holder by two dowels whereby the four spray orifices are fixed on a plane parallel to the piston top, and the nozzle fuel duct is registered with the holder fuel duct.

d. Fuel enters the nozzle holder fuel inlet passage, passes through the holder fuel duct into the nozzle fuel duct via an annular groove in the nozzle body, and then into the pressure chamber above the nozzle valve seat. At the instant the fuel pressure in the pressure chamber exceeds pressure exerted on spindle and nozzle valve by the spindle spring, the nozzle valve is lifted off its seat (popped) and fuel is forced through orifices in the valve body end and into the corresponding engine combustion chamber. The nozzle valve is returned to its seat by pressure exerted by the spindle spring when the fuel injection pump has ceased to deliver fuel to the nozzle holder.

### 14-38. Removal.

Refer to the Operator and Organizational Maintenance Manual to remove the nozzle holder assembly.

### 14-39. Disassembly, Cleaning and Repair.

NOTE

When more than one nozzle holder assembly is disassembled, keep parts of each separate. Complete disassembly of the nozzle holder assembly is seldom necessary. In most cases, only disassembly and cleaning of the nozzle valve body and valve is required to place the nozzle holder in good operational condition.

At completion of repair, check operation in accordance with paragraph 14-40.

The nozzle valve and nozzle valve body are mated parts, and must be kept together. If replacement of either part is necessary, both parts must be replaced as matched sets. Remove, clean, and inspect the nozzle valve body and valve as follows:

a. Clamp nozzle holder body in a suitable holding fixture.

b. Remove cap nut (10) and gasket (11) from upper end of nozzle holder (15). Loosen pressure adjusting screw locknut (8) and turn pressure adjusting screw (9) out sufficiently to release spring tension on spindle spring (12). See figure 14-19.

c. Using a suitable socket or box wrench, loosen and remove the nozzle retaining nut (5). Remove the nozzle valve body (3) and nozzle valve (4) from the retaining nut. Start the nut back onto the holder body to protect the lapped end of the holder body (15).

CAUTION

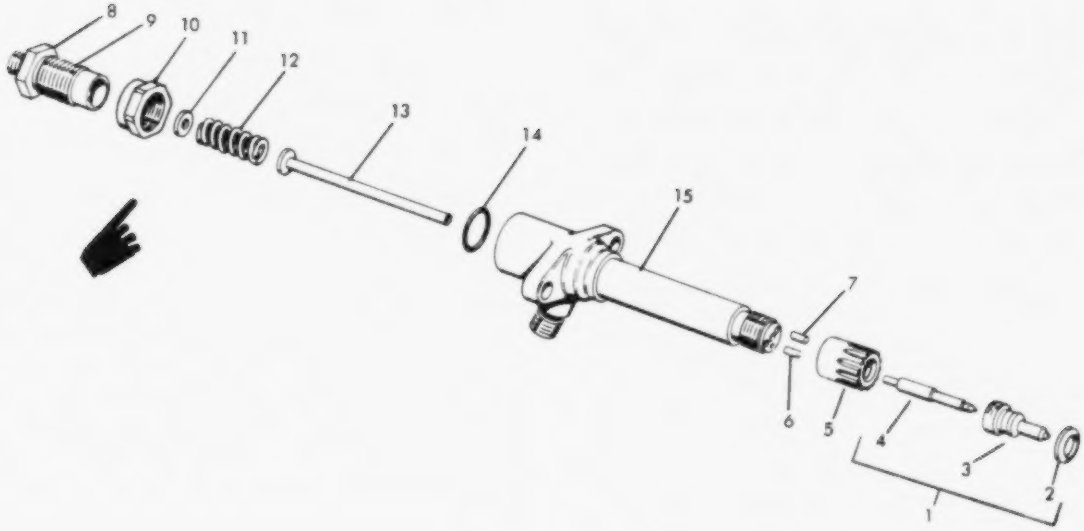
Do not allow the solution to get on the hands or body; use tweezers or the basket method to handle the parts.

d. Withdraw the valve from the valve body and place it in a carbon and rust remover solution for cleaning. Normally, the valve can easily be withdrawn from the valve body, however, in some cases it may be necessary to soak the valve body and valve in carbon removing compound Type 2 per Federal Specifications P-C-111 before the valve can be withdrawn. For faster and better cleaning results, the carbon removing compound should be heated to approximately 200° F. The parts generally can be separated in two or three minutes; however, if necessary they can be left in the solution longer. After removing the parts from the solution, immediately place them in clean diesel fuel for neutralizing. Always handle the parts carefully to protect the lapped surfaces.

e. The valve (4) and the seat in the valve body (3) are originally ground to slightly different angles to provide a line contact seat between the two parts. Practically all the wear occurs in the seat in the valve body. The valve should never be lapped to the seat in the valve body.

f. Using a magnifying glass, inspect condition of seat in the valve body (3). If the seat is damaged or worn in any way to prevent proper seating of the valve, the nozzle assembly (1) must be replaced.

g. The outer surfaces of the valve body (15) may be cleaned with a brass wire brush. Do not scrape carbon from the surface around the orifices in tip of valve body with any hard object as damage may result. Clean the four orifices in the valve body tip



ME 6115-545-34/14-19 C7

1. Nozzle assembly
2. Gasket
3. Nozzle body
4. Nozzle valve
5. Retaining nut
6. Dowel pin
7. Dowel pin
8. Locknut
9. Pressure adjust screw
10. Cap nut
11. Gasket
12. Spindle spring
13. Spindle
14. Gasket
15. Holder body

Figure 14-19. Nozzle Holder Assembly

with a cleaning wire and pin vise.

h. Visually inspect the condition of the valve (4), preferably with aid of a magnifying glass. The lapped surface (large outer diameter) of the valve must be smooth and free of signs of scoring. Also, the valve must not show any wear or damage at seat location. If the valve is damaged in any way, the nozzle assembly (1) must be replaced.

i. Thoroughly rinse the valve (4) and valve body (3) in clean diesel fuel. The valve must fit freely in the valve body. To check this fit, lift valve about one third of its length out of the body. The valve should slide down to its seat without aid when assembly is held at a 45° angle.

j. If the fit of the valve in the valve body is unsatisfactory, the valve may be cleaned and polished with lapping compound and castor oil used on tissue paper. The valve may be held by its stem in a revolving chuck for this cleaning operation. An orange stick or round toothpick will be helpful in cleaning the valve.

CAUTION

> Hard or sharp tools, emery cloth, crocus cloth, jeweler's rouge, grinding compounds, or other abrasives should never be used in cleaning.

k. Thoroughly rinse the valve (4) in clean diesel fuel before installing it in the valve body (3).

l. Examine the flat sealing surface of the valve body (surface which contacts lower end of the holder body) and make certain surface is clean and free of scratches. This surface may be lapped, if necessary, using lapping compound, castor oil, and a lapping block. After lapping, remove all traces of lapping compound with clean diesel fuel.

m. Make certain that the bottom flat seating surface of the nozzle holder body (15) is clean and in good condition. Rinse the valve (4) and valve body (3) in clean diesel fuel, then insert valve (4) into position in the valve body (3). Place the valve body (3) and valve (4) in position on the end of the nozzle holder body and center the valve body with the holder body (15). Install and tighten the nut (5) to a torque of 40 to 60 inch-pounds.

NOTE

It is important that the valve body be centered in the nozzle retaining nut. Use care while tightening the nozzle retaining nut so that the valve body remains centered in the nut.

n. If malfunctioning of the nozzle holder assembly was not corrected by removal and cleaning of the nozzle valve body and valve, disassemble and clean the nozzle holder as follows:

(1) Clamp nozzle holder (15) assembly in a holding fixture and remove the cap nut (10) and gasket (11) from upper end of nozzle holder. Loosen and remove the pressure adjusting screw locknut (8).

(2) Remove pressure adjusting screw (9), spindle spring (12), and spindle (13).

(3) Remove nozzle retaining nut (5), and disassemble the nozzle assembly.

(4) Place all parts in clean diesel fuel. Using filtered compressed air, blow out the fuel passages in the holder body.

(5) Visually inspect the parts for damage or wear; replace necessary parts. Examine the flat sealing surface of holder body (15) (surface which contacts upper end of valve body) and make certain the surface is clean and free from scratches. This surface should be lapped if necessary, using lapping compound, castor oil, and a lapping block. When lapping, use care to keep the nozzle holder body square with the lapping block to assure contact with the entire area being resurfaced. After lapping, remove all traces of the lapping compound with clean diesel fuel and dry with filtered compressed air.

(6) Examine the spindle spring (12). If the spring is scratched or pitted, it must be replaced. Also, the spring must be replaced if the ends have worn. Always replace springs when rebuilding injector.

(7) Rinse spindle (13) in clean fuel and insert it into holder body (15). Place the spindle spring (12) in position on spindle (13). Install pressure adjusting screw (9), pressure adjusting screw locknut (8), cap nut (10) and gasket (11); do not tighten at this time.

(8) Install nozzle valve (4), valve body (3), and nozzle retaining nut (5). Tighten nut to a torque of 40 to 60 foot-pounds.

o. When rebuilding an injector assembly, the nozzle assembly, spindle (13), spring (12), adjusting screw (9), and all gaskets (2,14,11) must be replaced.

## 14-40. Test and Adjustment.

WARNING

Keep hands away from nozzle tip when popping a nozzle. The finely atomized fuel is ejected with sufficient force to penetrate the skin and cause blood poisoning.

a. Use diesel injector test set tool (table 2-1) and test and adjust each nozzle as follows:

(1) Bolt or clamp base of nozzle tester to a work bench.

(2) Turn nozzle tester valve handle to the open position. Loosen filler cap to prevent air lock in the tester. Operate handle until fuel flows from end of tester fuel line, then close valve.

(3) Install nozzle in tester and connect line. Place spray collector under valve end of nozzle.

(4) Open nozzle tester valve. Operate handle a few quick strokes and observe popping pressure indicated on pressure gauge. Popping pressure for the injectors is 2900 ± 75 psi.

NOTE

New nozzles and rebuilt nozzles with new springs are set at 3100 to 3150 psi to compensate for initial set of new spindle springs.

b. Adjust nozzle to obtain popping pressure as follows:

(1) Remove cap nut (12) from upper end of nozzle and loosen adjusting screw locknut (9).

(2) While operating handle, turn pressure adjusting screw (8) in to increase or out to decrease popping pressure. When pressure is obtained, hold adjusting screw and tighten locknut to 60 to 75 foot-pounds torque.

c. Dry the nozzle tip. Operate handle slowly until pressure is approximately 200 psi below popping pressure. Observe nozzle tip for fuel leakage. If nozzle does not leak, the nozzle valve is seating properly in the valve body. If drops of fuel collect at a pressure of approximately 200 psi, or less, below popping pressure, the nozzle valve is not seating properly. In this case, the valve body and valve must be removed for cleaning and inspection.

d. If the nozzle proved satisfactory when subjected to the leakage test above, operate handle at a speed of approximately 100 strokes per minute and observe nozzle spray pattern.

e. The nozzle tip has four equally spaced holes, 90 degrees apart. Size and spacing of these holes determine the spray pattern. If fuel is discharged evenly through all four holes at specified popping pressure, the spray pattern is considered satisfactory. However, if fuel is not discharged evenly from all four holes, a plugged hole(s) is indicated, in which case, the nozzle must be removed and cleaned using a proper size cleaning wire.

f. Install nozzle holder cap nut and tighten it to 60 to 75 foot-pounds torque.

### 14-41. Nozzle Holder Assembly Installation.

Install the nozzle holder assembly. Refer to Operator and Organizational Maintenance Manual.

## Section VIII. FUEL INJECTION PUMP AND RELATED PARTS

### 14-42. General.

a. The fuel injection pump is a single cylinder, opposed plunger, inlet metering, distributor type. The plungers are operated by an internal cam ring. The purpose of the pump is to accurately deliver metered quantities of fuel under high pressure to the nozzle holder assemblies through which the fuel is introduced into the engine combustion chambers, at a definite timing in relation to the engine firing cycle, and within the required injection period.

b. On Class 1, Precise Sets, the fuel injection pump is controlled by the hydraulic actuator. The hydraulic actuator operates on the shut down lever to automatically control fuel flow through the fuel injection pump, dependent upon load conditions, and thus controls engine speed and response to load changes.

c. On Class 2, Utility Sets, this fuel injection pump is manually controlled from the control located at the rear of the set. The manual control is connected to the throttle through a cable and sleeve assembly.

d. The fuel injection pump also has an integral back-up governor of the mechanical centrifugal (flyweight) type. This governor is driven directly off the pump drive shaft without gearing.

e. The transfer or supply pump, in the opposite end of the rotor from the pumping cylinder, is a positive displacement vane type enclosed by the end plate. The pump is self-lubricated by the fuel supply.

f. Fuel shut-off is accomplished electrically by a solenoid mechanism within the fuel pump. When energized, the solenoid opens the metering valve to permit fuel flow to the engine.

g. An external adjustment knurled screw at the rear of the pump housing provides precise control of governor sensitivity by decreasing or increasing the effective length of the governor control spring. Turning the adjustment screw inward shortens the control spring, making it less sensitive and increasing speed droop. Turning the screw outward has the opposite effect. Regulation of 2-3 percent can be easily attained and adjustment can be made while the engine is operating.

### 14-43. Fuel Injection Pump Removal and Disassembly.

a. Symptoms and Isolation of Malfunction. A malfunction of the fuel injection pump is usually indicated by loss of engine speed and power, erratic engine speed, failure of engine to start (when electric starter is working correctly), or sudden engine shutdown when there is no fault indication such as low fuel, high coolant temperature, or low oil pressure. To isolate the malfunction to the fuel injection pump, proceed as follows:

(1) Check fuel lines and fuel injection pump for visible signs of leakage.

(2) If engine cannot be started or if it has shut down suddenly, loosen the fuel input line to the fuel injection pump. If a full line of fuel is available, it may be an indication that the pump has failed. Tighten the coupling.

(3) While engine is cranking, loosen the input to one of the fuel injectors. If there is no evidence of available fuel, the fuel injector pump has failed.

(4) Remove timing cover on pump and observe that pump rotates when engine cranks.

(5) Check for 24 Vdc at solenoid terminals on top cover of injection pump.

(6) Check solenoid (para 14-46). If no continuity, replace solenoid.

(7) Refer to table 14-1 for troubleshooting the fuel injection pump.

b. Removal. (See figure 14-20.)

(1) Refer to the Operator and Organizational Maintenance Manual and drain fuel day tank and disconnect fuel line to pump.

Table 14-1. Fuel Injection Pump Troubleshooting Chart

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| ON TEST STAND FOLLOWING OVERHAUL | | |
| 1. Fuel not reaching pump. | Transfer pump liner locating pin in wrong hole for correct rotation. | Re-install properly. (para 14-45) |
| 2. Fuel delivered from transfer pump but not to nozzles. | a. Plunger missing. | a. Assemble new plunger. (para 14-45) |
| | b. Cam backwards in housing. | b. Reassemble correctly. (para 14-45) |
| | c. Metering valve incorrectly assembled to metering valve arm. | c. Reassemble correctly. (para 14-45) |
| | d. Metering valve spring shim missing. | d. Install as indicated in paragraph 14-45. |
| | e. Hydraulic head vent wires missing. | e. Install as indicated in paragraph 14-44. |
| | f. Head plug screws loose or missing. | f. Install as indicated in paragraph 14-44. |
| 3. Inadequate pressure at nozzle | Head plug screws loose or missing. | Install as indicated in paragraph 14-44. |
| 4. Erratic pump output - surge, poor governor regulation | a. Delivery valve sticking, missing or assembled backwards. | a. Remove, clean or replace as needed. (para 14-45) |
| | b. Metering valve spring shim missing. | b. Install as indicated in paragraph 14-45. |
| | c. Head plug screws loose or missing. | c. Install as indicated in paragraph 14-44. |
| 5. Insufficient pump output volume. | a. Delivery valve sticking, missing or assembled backwards. | a. Remove, clean or replace as needed. (para 14-45) |
| | b. Hydraulic head vent wires missing. | b. Install as indicated in paragraph 14-44. |
| | c. Head plug screws loose or missing. | c. Install as indicated in paragraph 14-44. |

Table 14-1. Fuel Injection Pump Troubleshooting Chart (Cont)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| FOLLOWING INSTALLATION ON ENGINE | | |
| 1. Fuel not reaching pump. | Seizure of distributor rotor. | Check for cause of seizure. Replace hydraulic head and distributor rotor assembly. (para 14-45 |
| 2. Fuel delivered from transfer pump but not to nozzles. | a. One or more connector screws obstructed. | a. Replace. (para 14-45) |
| | b. Failure of electrical shut-off. | b. Remove, inspect and adjust parts. Replace parts as necessary. (para 14-46) |
| 3. Engine starts hard. | One or more connector screws obstructed. | Replace. (para 14-45) |
| 4. Engine starts and stops. | Failure of electrical shut-off. | Remove, inspect and adjust parts. Replace parts as necessary. (para 14-46) |
| 5. Engine does not develop full power or speed. | One or more connector screws obstructed. | Replace. (para 14-45) |
| DURING OPERATION | | |
| 1. Fuel delivered from transfer pump but not to nozzles. | a. Plungers sticking. | a. Disassemble and inspect for burrs, corrosion or varnishes. (para 14-44). |
| | b. Metering valve sticking or closed. | b. Check for governor linkage binding, foreign matter, burrs, etc. (para 14-44). |
| | c. Passage from transfer pump to metering valve clogged with foreign matter. | c. Disassemble and flush out hydraulic head. (para 14-45) |
| | d. Governor spring worn or broken. | d. Remove and replace. (para 14-45) |
| | e. Governor linkage loose. | e. Remove, replace and readjust. (para 14-45) |
| | f. Governor not operating; parts or linkage worn, sticking or binding, or incorrectly assembled. | f. Disassemble, inspect parts, replace if necessary and reassemble. (para 14-45) |
| | g. Rotor badly scored. | g. Replace hydraulic head and rotor assembly. (para 14-45) |
| 2. Fuel reaching nozzles but engine will not start. | a. Pump timed incorrectly to engine. | a. Correct timing. (para 14-49) |
| | b. Excessive fuel leakage past plungers (worn, badly scored). | b. Replace rotor and hydraulic head assembly. (para 14-45) |
| | c. Cam, shoes or rollers worn. | c. Remove and replace. (para 14-45). |
| | d. Automatic advance faulty or not operating. | d. Remove, inspect, correct and reassemble. (para 14-45) |

Table 14-1. Fuel Injection Pump Troubleshooting Chart (Cont)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| | DURING OPERATION (Cont) | |
| | e. Maximum fuel setting at low limit or too low. | e. Adjust per paragraph 14-45. |
| 2. Fuel reaching nozzles but engine will not start. (Cont) | f. Throttle arm travel not sufficient. | f. Check installation and adjust throttle linkage. (para 14-45) |
| | g. Rotor badly scored. | g. Replace hydraulic head and rotor assembly. (para 14-45) |
| 3. Engine starts hard. | a. Transfer pump blades worn or broken. | a. Replace. (para 14-45) |
| | b. Delivery valve retainer screw loose and leaking or incorrectly installed. | b. Inspect delivery valve stop seat for erosion, tighten retainer screw, or replace head and rotor assembly as needed. (para 14-45) |
| | c. Plungers sticking. | c. Disassemble and inspect for burrs, corrosion or varnishes. (para 14-45) |
| | d. Metering valve sticking or closed. | d. Check for governor linkage binding, foreign matter, burrs, etc. (para 14-45) |
| | e. Pump timed incorrectly to engine. | e. Correct timing. (para 14-49) |
| | f. Excessive fuel leakage past plungers (worn or badly scored). | f. Replace rotor and hydraulic head assembly. (para 14-45) |
| | g. Transfer pump faulty, pressure too low. | g. Remove and inspect parts. (para 14-45) |
| | h. Cam, shoes or rollers worn. | h. Remove and replace. (para 14-45) |
| | i. Automatic advance faulty or not operating. | i. Remove, inspect, correct and reassemble. (para 14-45) |
| | j. Governor linkage out of adjustment. | j. Adjust governor. (para 14-44) |
| | k. Governor not operating; parts or linkage worn, sticking or binding, or incorrectly assembled. | k. Disassemble, inspect parts, replace if necessary and reassemble. (para 14-45) |
| | l. Maximum fuel setting at low limit or too low. | l. Adjust pump per paragraph 14-48. |
| | m. Shut-off device interfering with governor linkage. | m. Check and adjust governor linkage dimensions. (para 14-45) |
| | n. Rotor badly scored. | n. Replace hydraulic head and rotor assembly. (para 14-45) |
| 4. Engine starts and stops. | a. Failure of electrical shut-off. | a. Remove, inspect and adjust parts. Replace parts as necessary. (para 14-46) |

Table 14-1. Fuel Injection Pump Troubleshooting Chart (Cont)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| DURING OPERATION (Cont) | | |
| 4. Engine starts and stops. (Cont) | b. Transfer pump blades worn or broken. | b. Replace. (para 14-45) |
| | c. Plungers sticking. | c. Disassemble and inspect for burrs, corrosion or varnishes. (para 14-45) |
| | d. Metering valve sticking or closed. | d. Check for governor linkage binding, foreign matter, burrs, etc. (para 14-45) |
| | e. Cam, roller, or shoes sticking. | e. Remove, check for size and burrs and reassemble. (para 14-45) |
| 5. Erratic engine operation-surge, misfiring, poor governor regulation. | a. Transfer pump blades worn or broken. | a. Replace. (para 14-45) |
| | b. Delivery valve retainer screw loose and leaking or incorrectly installed. | b. Inspect delivery valve stop seat for erosion, tighten retainer screw, or replace head and rotor assembly as needed. (para 14-45) |
| | c. Plungers sticking. | c. Disassemble and inspect for burrs, corrosion or varnishes. (para 14-45) |
| | d. Metering valve sticking or closed. | d. Check for governor linkage binding, foreign matter, burrs, etc. (para 14-45) |
| | e. Governor spring worn or broken. | e. Remove and replace. (para 14-45) |
| | f. Cam, roller, or shoes sticking. | f. Remove, check for size and burrs and reassemble. (para 14-45) |
| | g. Pump timed incorrectly to engine. | g. Correct timing. (para 14-49) |
| | h. Transfer pump faulty, pressure too low. | h. Remove and inspect parts. (para 14-45) |
| | i. Automatic advance faulty or not operating. | i. Remove, inspect, correct and reassemble. (para 14-45) |
| | j. Governor linkage out of adjustment. | j. Adjust governor. (para 14-45) |
| | k. Governor not operating; parts or linkage worn, sticking or binding. | k. Disassemble, inspect parts, replace if necessary and repair. (para 14-45) |
| | l. Wrong governor spring. | l. Remove and replace with proper spring. (para 14-45) |
| | m. Pump housing not full of fuel. | m. Operate engine for approximately 5 minutes until pump fills with fuel. |
| | n. Governor sleeve binding on drive shaft. | n. Remove, inspect for burrs, dirt, etc. Correct and reassemble. (para 14-45) |

Table 14-1. Fuel Injection Pump Troubleshooting Chart (Cont)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| DURING OPERATION (Cont) | | |
| 5. Erratic engine operation-surge, misfiring, poor governor regulation. (Cont) | o. End plate regulating piston sticking. | o. Remove piston and sleeve and inspect for burrs, corrosion or varnishes. Replace if necessary. (para 14-45) |
| | p. Variable speed droop device incorrectly adjusted or faulty. | p. Replace if necessary. (para 14-47) |
| 6. Engine does not develop full power or speed. | a. One or more connector screws obstructed. | a. Replace. (para 14-45) |
| | b. Transfer pump blades worn or broken. | b. Replace. (para 14-45) |
| | c. Delivery valve retainer screw loose and leaking or incorrectly installed. | c. Inspect delivery valve stop seat for erosion, tighten retainer screw, or replace head and rotor assembly as needed. (para 14-45) |
| | d. Plungers sticking. | d. Disassemble and inspect for burrs, corrosion or varnishes. (para 14-45) |
| | e. Metering valve sticking or closed. | e. Check for governor linkage binding, foreign matter, burrs, etc. (para 14-45) |
| | f. Pump timed incorrectly to engine. | f. Correct timing. (para 14-44) |
| | g. Excessive fuel leakage past plungers (worn or badly scored). | g. Replace rotor and hydraulic head assembly. (para 14-45) |
| | h. Transfer pump faulty, pressure too low. | h. Remove and inspect parts. (para 14-45) |
| | i. Cam, shoes or rollers worn. | i. Remove and replace. (para 14-45) |
| | j. Automatic advance faulty or not operating. | j. Remove, inspect, correct and reassemble. (para 14-45) |
| | k. Governor linkage out of adjustment. | k. Adjust governor. (para 14-45) |
| | l. Governor not operating; parts or linkage worn, sticking or binding, or incorrectly assembled. | l. Disassemble, inspect parts, replace if necessary and reassemble. (para 14-45) |
| | m. Maximum fuel setting at low limit or too low. | m. Reset to pump specification. (para 14-48) |
| | n. Wrong governor spring. | n. Remove and replace with proper spring as in pump specification. (para 14-45) |

Table 14-1. Fuel Injection Pump Troubleshooting Chart (Cont)

| MALFUNCTION | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| | **DURING OPERATION (Cont)** | |
| 6. Engine does not develop full power or speed. (Cont) | o. Shut-off device interfering with governor linkage. | o. Check and adjust governor linkage dimensions. (para 14-45) |
| | p. Governor high-idle adjustment incorrect. | p. Adjust. (para 14-45) |
| | q. Throttle arm travel not sufficient. | q. Check installation and adjust throttle linkage. (para 14-45) |
| | r. Rotor badly scored. | r. Replace hydraulic head and rotor assembly. (para 14-45) |
| 7. Engine smokes black. | a. Pump timed incorrectly to engine. | a. Correct timing. (para 14-49) |
| | b. Cam, shoes or rollers worn. | b. Remove and replace. (para 14-45) |
| | c. Automatic advance faulty or not operating. | c. Remove, inspect, correct and reassemble. (para 14-45) |
| | d. Maximum fuel setting too high. | d. Reset. (para 14-48) |
| 8. Engine smokes blue or white. | a. Pump timed incorrectly to engine. | a. Correct timing. (para 14-49) |
| | b. Automatic advance faulty or not operating. | b. Remove, inspect, correct and reassemble. (para 14-45) |

(2) Check that the timing line on the governor weight retainer hub is opposite the line on the pump cam.

(3) Disconnect all fuel lines and plug all openings.

(4) Disconnect throttle and shut-off linkage and disconnect electrical leads from solenoid.

(5) Remove mounting nuts on the pump flange.

(6) Slide pump gently from location. Be careful not to damage the pilot tube by cocking pump on removal.

c. Disassembly. Disassemble the pump in the numerical sequence illustrated in figure 14-21 paying particular attention to the following:

CAUTION

Never clamp the pump in a vice without using the fixture.

(1) Mount pump in holding fixture and secure in vice.

(2) Remove three screws (1) and remove cover (4). Set cover containing solenoid aside for later disassembly. Refer to paragraph 14-46.

(3) Rotate shut-off lever (21) to full off position; pry gently between housing and linkage hook (45) and remove shut-off cam (25).

(4) Partially withdraw throttle shaft assembly (26) and lift out throttle shaft lever (40), spacers and governor arm damper barrel assembly (86). Remove throttle shaft and shut-off shaft assemblies (24).

(5) Hold metering valve (93) and arm assembly (91) down and lift linkage hook (45) from metering valve arm pin (91). Disengage hook from governor arm (86). Do not separate linkage hook from spring unless necessary to replace one of these parts.

(6) Remove the end plate assembly (58). Remove the speed droop adjusting cap (73) by pulling to the rear of the pump. With a pair of needle nose pliers, remove the control rod clip (78).

CAUTION

Do not bend the control rod.

Loosen and remove the control rod guide (75), O ring (77) and guide washer (76). Disengage the governor spring (80) from the governor arm (86) and remove the governor spring (80) and control rod assembly (79) as a unit.

(7) Remove metering valve (93) and arm assembly (91) from hydraulic head.

NOTE

Metering valve is shimmed to reduce vertical play. If valve, arm or head, and rotor assembly are not replaced, save shims and spacer for reassembly.

(8) Remove two head locking screws (146, 147) from pump housing (166).

(9) Invert pump and holding fixture as a unit and remove head locating screw (103), advance screw hole plug (100), and remove advance pin (102).

(10) Remove the power piston plug (111) and advance spring components (97-113) as an assembly. Disassemble by removing cap (115) and loosening jam nut (114) and back trimmer screw (112) completely in. Slide the piston (99) out of the plug (do not turn piston inside of plug). Remove the retaining ring (110) from the piston (99) and remove spring (108) and trimmer screw (112).

NOTE

The sides of the housing just above the advance bears a "C" denoting clockwise pump rotation as viewed from the drive end. The power side of the piston is located on the "C" side of a clockwise rotation pump.

(11) Invert the holding fixture in the vise. Grasp the hydraulic head assembly firmly in both hands and withdraw with a slight rotary motion. Use caution not to drop the governor weights (116).

(12) To disassemble the governor, invert the hydraulic head and rotor assembly (145) and let weights (116), governor thrust sleeve (117), and governor thrust sleeve wahser (118) fall into your hand.

(13) Place the hydraulic head assembly on pump holding fixture so that the governor weight retainer (123) engages the bar on the fixture.

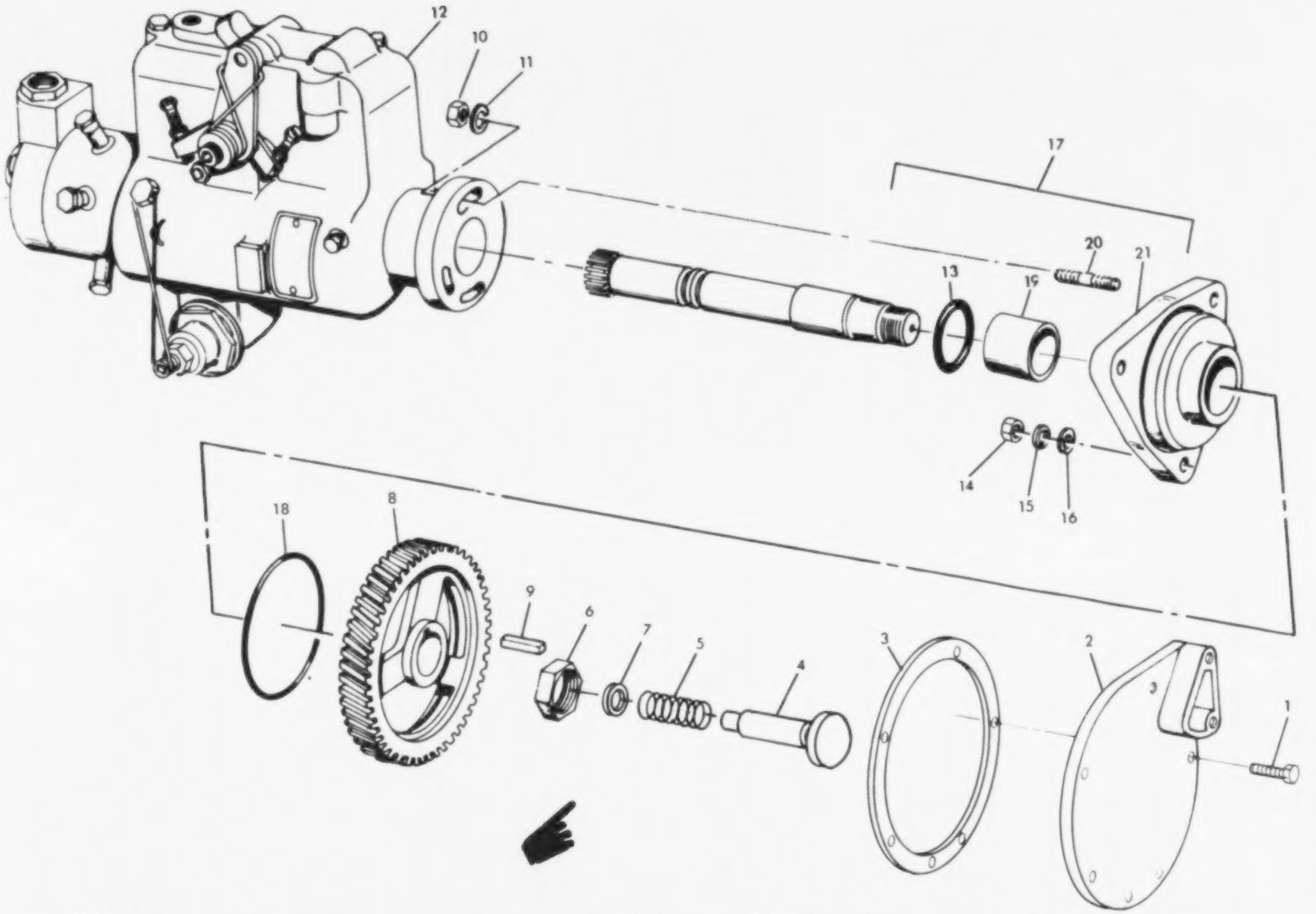
(14) Remove the pressure regulating sleeve (49) from end plate (59). Slide off the inlet screen (51). Remove the adjusting plug (48). Shake out the regulating spring (54) and piston (55). Reverse the assembly and remove the regulating piston seal (56).

(15) To disassemble transfer pump, lift out transfer pump seal (71), liner (72) and blades (67-70), and springs (65, 66).

(16) Using a 5/32 inch Allen wrench, loosen the delivery valve retainer screw (138) and remove it.

(17) Lift head and rotor assembly and shake delivery valve stop (139), spring (140), and delivery valve (141) into the hand.

(18) Using a small-bladed screwdriver or a dull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1. Screw
2. Cover
3. Gasket
■4. Screw
5. Spring
6. Nut
■7. Washer
8. Gear
9. Key
10. Nut
11. Washer
12. Fuel pump
13. Seal
14. Nut
15. Washer
16. Washer
17. Adapter assy
18. Performed packing
19. Bushing
20. Stud
21. Adapter

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Figure 14-20. Injector Pump and Related Parts

scribe, disengage and remove the rotor retainer snap ring (119). This releases the rotor retainers (120) which should now be moved outward as far as possible to clear the rotor. Gently lift the hydraulic head (144) off the distributor rotor (142). Invert the head and shake out the rotor retainers (120).

(19) Lift off cam ring (122). Check and record roller-to-roller dimension as instructed in assembly procedure. This dimension should be 1.977 ± 0.0005. Remove rollers (129, 130), shoes (131, 132) and plungers (133, 134), only if damaged. Otherwise secure these parts by using the transfer pump seal (71).

NOTE

> Reassembly may be more easily accomplished if the leaf springs (127, 128) are not removed and shoes with rollers remain installed in their original positions. Leaf springs, if removed, should first be marked with a dye for original position reassembly. Do not remove locating pin from spline end of rotor.

(20) Remove the governor weight retainer snap ring (121) using snap ring pliers.

(21) Using suitable tool and supporting the head on a flat surface, press the rotor (142) from the weight retainer (123).

(22) The flexible retaining ring should be replaced whenever the pump is disassembled. Insert the snap ring pliers in the closed position, under the flexible retaining ring between any two of the rivets. Expand the pliers while applying pressure in an upward direction. A slight twisting motion will snap the ring off the rivet. Repeat this process until the retaining ring is free from all rivets. Discard the flexible retaining ring.

14-44. Fuel Injection Pump, Inspection and Repair.

a. Inspection.

(1) Transfer pump blades. Inspect carefully. Check for chipping on any of the edges, pitting, imbedded foreign particles or wear on the rounded ends. Inspect flat surfaces visually for scores.

(2) Plungers. While holding the rotor under clean oil, insert the plungers into their bore. With thumb and forefinger over the guide slots, tilt from side to side several times to insure complete freedom of movement. Interchanging or reversing their individual position may be necessary, as these are matched parts. Repeat with short set without removing first set. Replace defective parts. If the plungers stick, but are not visibly damaged, clean both plungers and bore with a soft brush and lacquer-removing solvent such as lacquer thinner or acetone. (Do not force plungers into their bore and do not handle rotor shank).

(3) Distributor head and rotor. Examine the radii contacted by the leaf springs, and the weight retainer drive spline for wear. Check all slots, charging and discharge ports for chipping or erosion of edges and the rotor shank for scratches. If damage or excessive wear is apparent, the head and rotor must be replaced as a mated unit. Examine the rotor timing pin for damage. Check alignment of tang (at side of rotor locating pin) with center of shoe slot and rotor discharge port.

(4) Hydraulic head vent wires. Check the vent wire in the hydraulic head air bleed passage for freedom of movement. If the wire is free, flush the head and blow out all passages with clean, dry air. If vent wire is stuck, replace it after thorough cleaning of the passage.

(5) Cam rollers and shoes. Check each roller in its shoe for freedom of rotation, and the top edge of each shoe, where retained by the leaf spring, for chipping or excessive wear. Improved roller surfaces will result from long, normal operation in clean fuel.

(6) Leaf springs. Check for cracks, nicks, or chipping, or distortion of leaf spring and wear at points where the radii on the rotor and along the steps that retain the roller shoes.

(7) Governor weights and retainer. Examine the retainer sockets where weights pivot, and pivot points of all weights for wear and replace the flexible retaining ring (119). If the retainer can be assembled to the distributor rotor by hand, the retainer hub must be replaced. This assembly must be a press fit. No free play should be evident when the retainer is assembled to the rotor.

(8) Governor linkage. Inspect the pivot points of the governor arm (86) and pivot shaft (85). Examine the governor arm toes where they contact the thrust sleeve. If they are worn flat on either toe, discard and replace. The linkage gap should not exceed 0.025 inch. Examine the metering valve pin hole in the linkage hook, throttle lever (40), shut-off cam (25), and especially the throttle and shut-off assemblies where joined, for looseness or burrs.

(9) Metering valve and arm assembly. Check the metering valve body (93) for wear. Be sure the metering valve arm (91) is well seated and that there is no radial movement of the arm on the valve. Check the metering valve arm pin for wear or looseness.

(10) Cam. Since only the working portions of the lobes on the bore are ground, the tool marks between lobes should not be considered damaged. The cam finish is mottled from heat treatment rather than operation. Carefully inspect the bore and edges of all flat surfaces. If there is evidence of spalling or flaking out, replace with new cam. Improved cam lobe finish will result from long, normal operation in clean fuel oil.

KEY to fig. 14-21

1. Screw - cover
2. Washer - cover lock
3. Washer - cover flat
4. Cover - mech. gov
5. Connector - return
6. Gasket
7. Nut - terminal
8. Nut - lock
9. Washer
10. Washer, insulating
11. Tube - electric shut off
12. Tube - electric shut off
13. Spring
14. Spring sleeve
15. Arm, shut-off
16. Frame assy - electric shut off
17. Screw
18. Washer
19. Screw
20. Washer
21. Lever - shut off
22. Screw - stop
23. Nut
24. Shaft assy - shut off
25. Cam - shut off
26. Throttle shaft assy
27. Screw
28. Nut
29. Screw
30. Retainer
31. Spring throttle override
31A. Stop lever fitting screw
32. Lever assy - throttle
33. Washer
34. Washer
35. Seal
36. Seal
37. Cap
38. Spacer
39. Spacer
40. Lever - throttle shaft
41. Hook assy - linkage
42. Screw - gap adj.
43. Washer
44. Linkage
45. Hook - linkage
46. Spring - linkage
47. Plug
48. Plug - adjusting
49. Sleeve - press regulating
50. Packing, preformed
51. Screen inlet
52. Seal - flat
53. Ring, retaining
54. Spring pressure regulating
55. Piston, regulating
56. Seal, regulating piston
57. Regulating sleeve assy
58. End plate assy
59. Plate - end
60. Screw
61. Washer, lock
62. Washer, flat
63. Disk thrust
64. Pin
65. Spring - blade
66. Spring - blade
67. Blade - transfer pump
68. Blade - transfer pump
69. Blade - transfer pump
70. Blade - transfer pump
71. Seal - transfer pump
72. Liner - transfer pump
73. Adjusting cap - speed droop
74. Seal
75. Guide, control rod
76. Washer
77. "O" ring
78. Clip
79. Control rod assy - speed droop
80. Spring - governor
81. Nut - pivot shaft
82. Nut - pivot shaft
83. Seal - pivot shaft
84. Seal - pivot shaft
85. Shaft - pivot
86. Arm - governor
87. Piston assy - damper
88. Barrel assy - damper
89. Spring - damper
90. Washer
91. Arm assy - metering valve
92. Shim
93. Valve - metering
94. Spacer
95. Shim
96. Plug piston
97. Seal
98. Seal
99. Piston
100. Plug, advance screw hole
101. Seal
102. Pin - advance
103. Screw - head locating
104. Seal
105. Seal
106. Seal - Piston ring expander
107. Ring - piston
108. Spring/s advance
109. Washer
110. Ring - retaining
111. Plug - piston (power)
112. Screw - trimmer
113. Seal
114. Nut - trimmer screw lock
115. Cap
116. Weight, governor
117. Sleeve, thrust
118. Washer
119. Ring, rotor retainer
120. Retainer/s - rotor
121. Ring, governor retainer
122. Cam, ring
123. Governor weight retainer
124. Gasket
125. Screw - fuel adj.
126. Screw - fuel adj.
127. Spring, leaf
128. Spring, leaf
129. Roller
130. Roller
131. Shoe
132. Shoe
133. Plunger
134. Plunger
135. Screw - connector
136. Washer
137. Washer
138. Screw - delivery valve
139. Stop
140. Spring
141. Valve - delivery
142. Rotor
143. Seal, hydraulic head
144. Hydraulic head
145. Hydraulic head & rotor assembly
146. Screw - head locking
147. Screw - head locking
148. Screw - timing plate
149. Screw - timing plate
150. Cover - timing
151. Cover - timing
152. Gasket - timing plate
153. Gasket - timing plate
154. Screw - plug torque hole.
155. Washer - plug torque hole.
156. Screw - name plate
157. Plate - identification
158. Stop - throttle
159. Screw - plug, torque hole.
160. Washer - plug, torque hole.
161. Seal - pilot tube
162. Shaft assy - drive
163. Seal - drive shaft
164. Seal
165. Seal
166. Housing assy

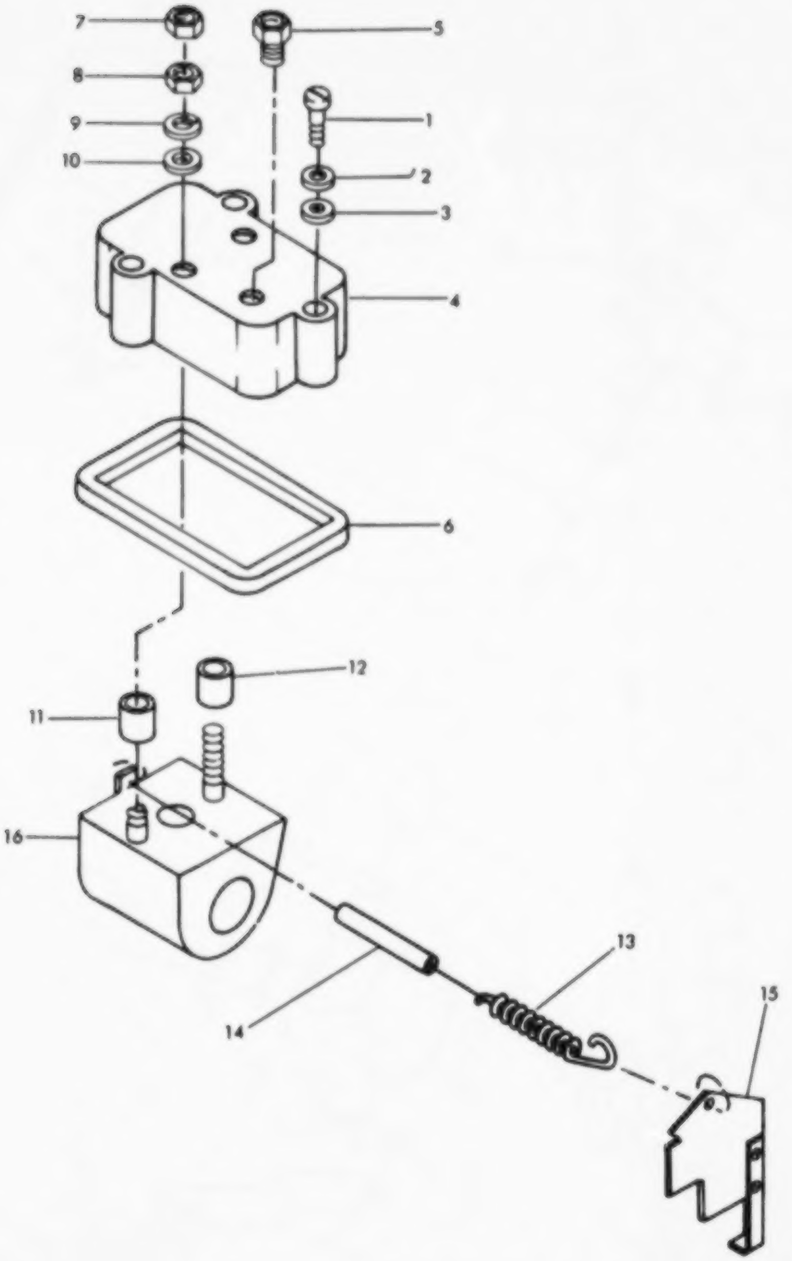
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Figure 14-21. Fuel Injection Pump Assembly (Sheet 1 of 7)

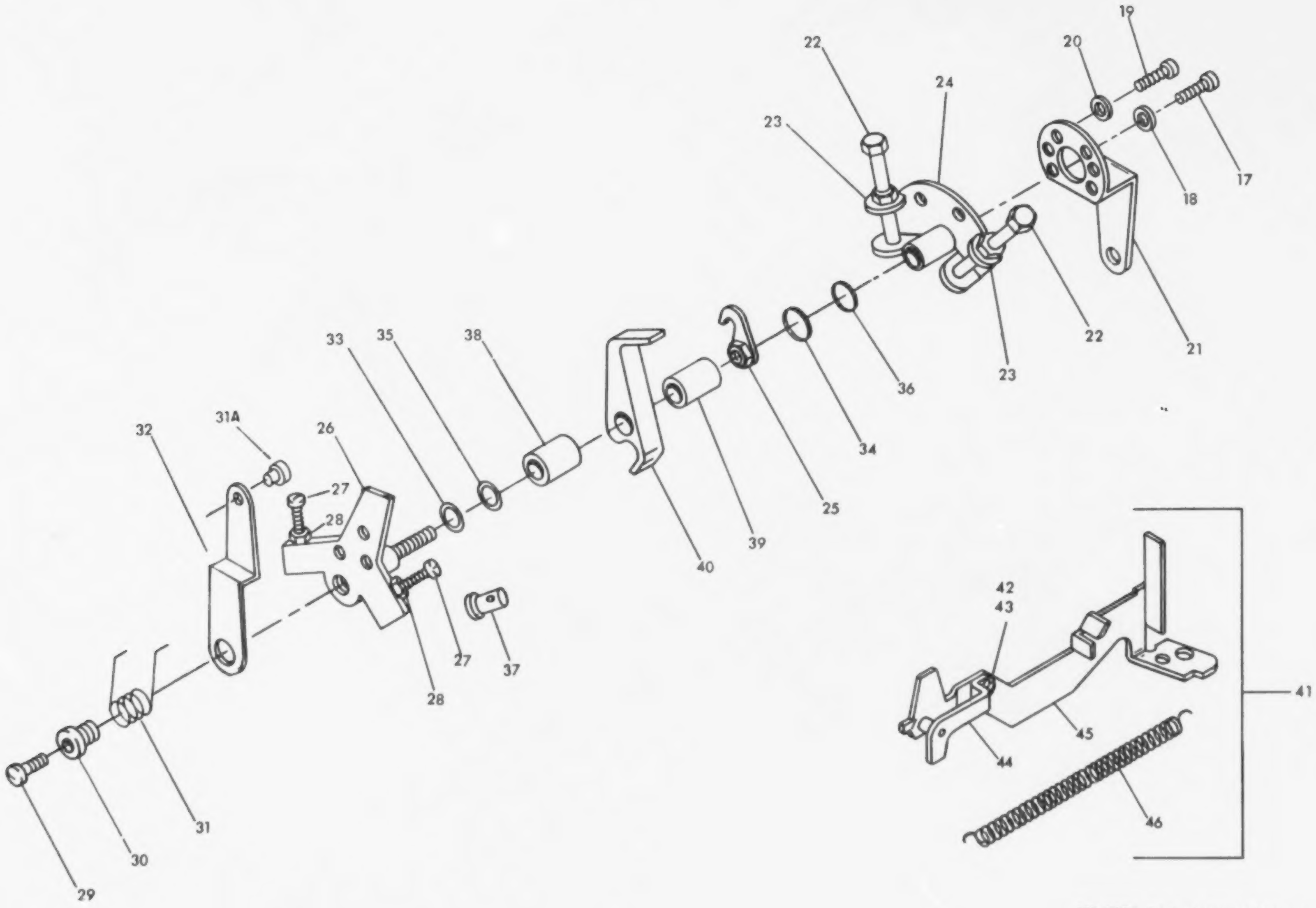
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Figure 14-21. Fuel Injection Pump Assembly (Sheet 2 of 7)

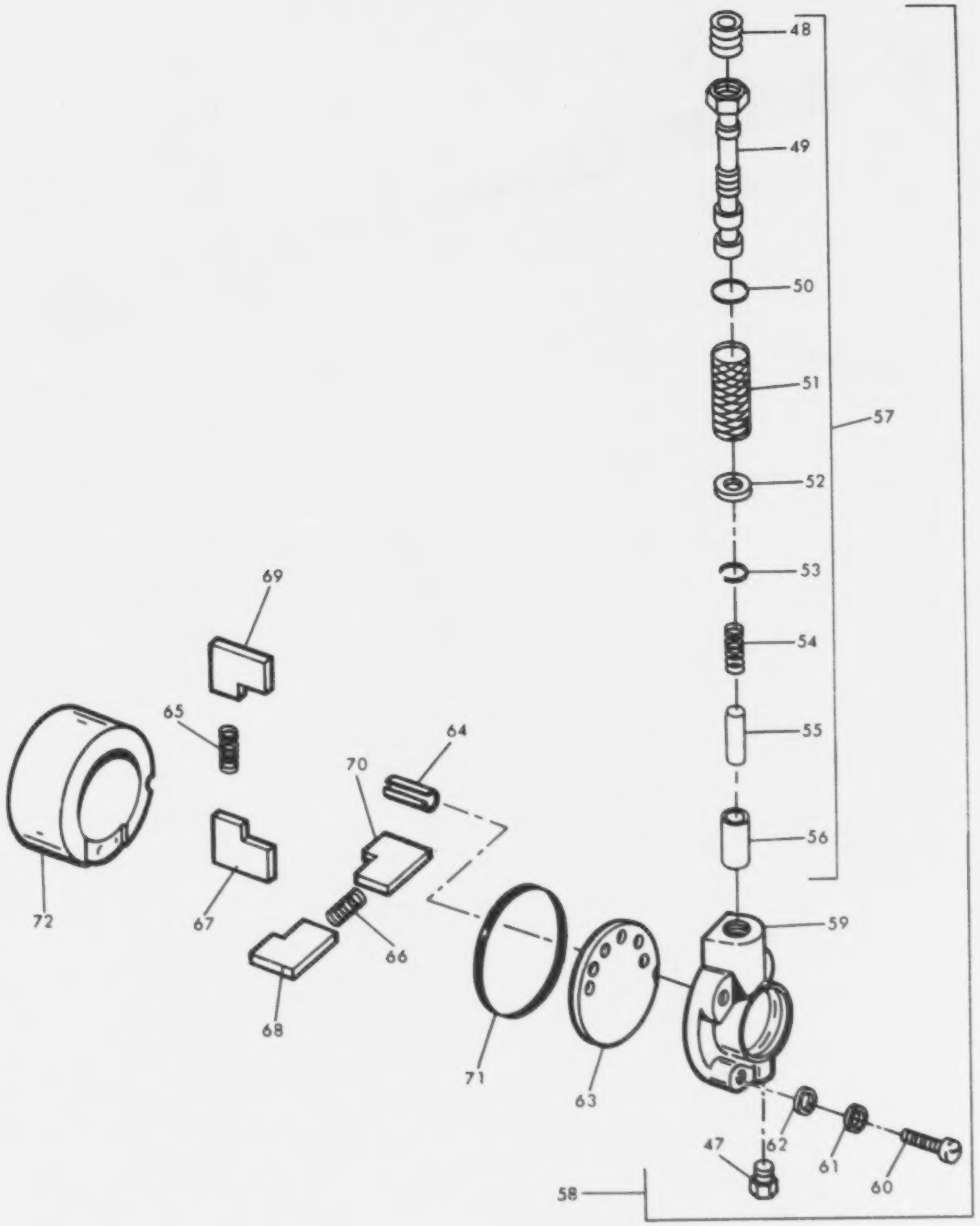
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Figure 14-21. Fuel Injection Pump Assembly (Sheet 3 of 7)

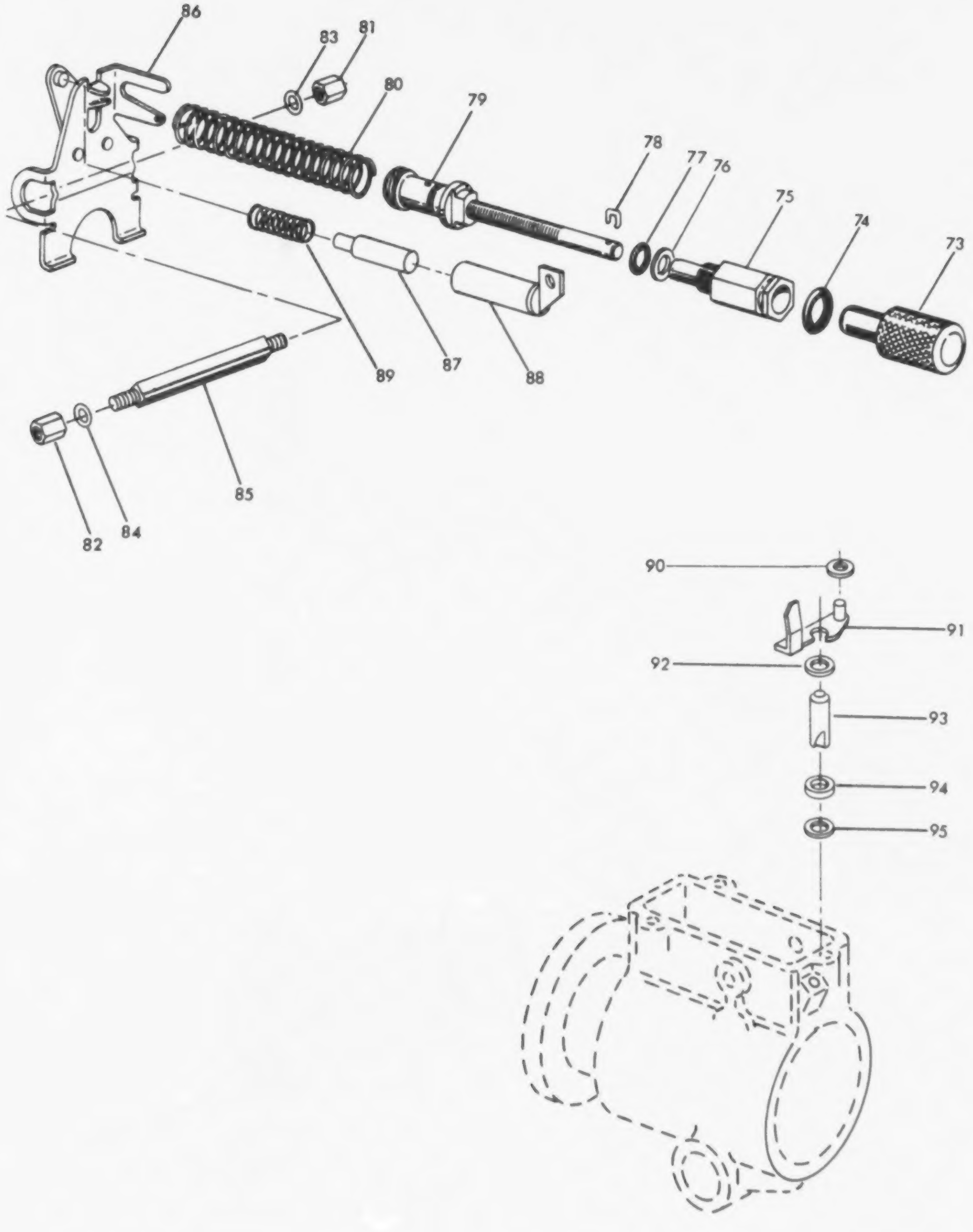
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Figure 14-21. Fuel Injection Pump Assembly (Sheet 4 of 7)

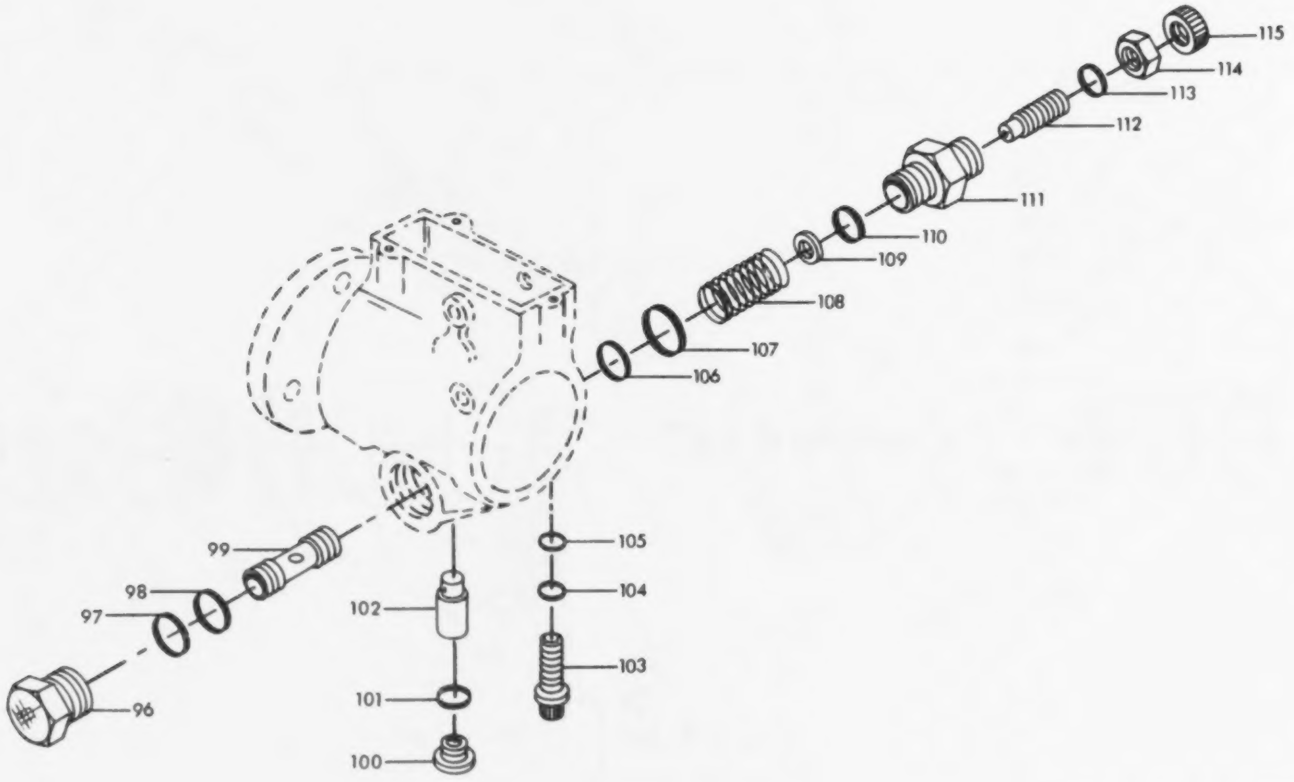
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Figure 14-21. Fuel Injection Pump Assembly (Sheet 5 of 7)

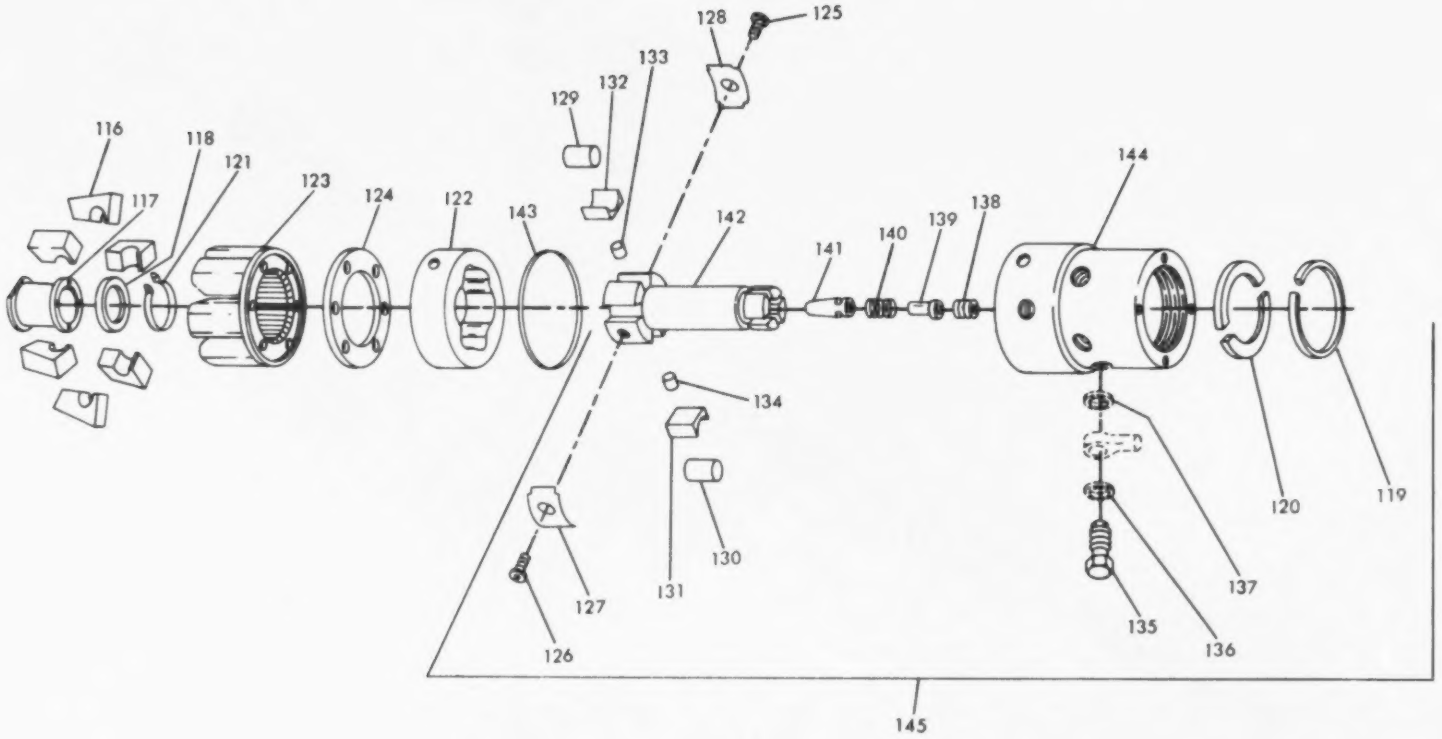
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Figure 14-21. Fuel Injection Pump Assembly (Sheet 6 of 7)

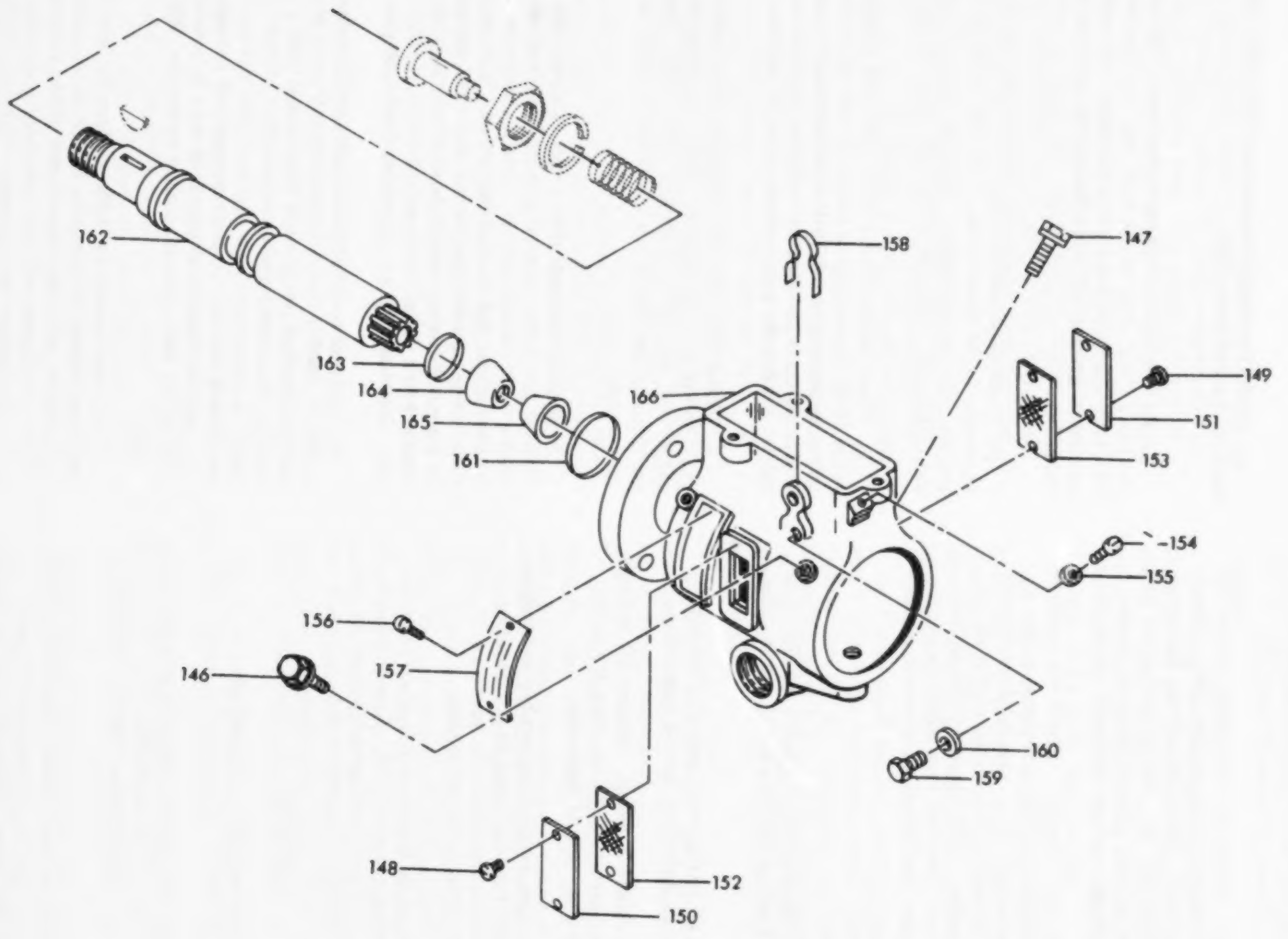
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Figure 14-21. Fuel Injection Pump Assembly (Sheet 7 of 7)

(11) Drive shaft. Inspect the shaft for undue wear or cracking. Check the shaft diameter where the governor thrust sleeve (117) slides for scoring. The drive shaft seal grooves must be absolutely smooth for the seals to function properly. Check for alignment of timing roll pin on splined drive shafts.

(12) End plate. Check the regulating piston (55) for freedom of movement in the sleeve (49). Check all threads for damage. The inlet screen (51) must be inspected for damage. All dirt or rust must be removed from the screen. Do not attempt to remove liner-locating pin unless obviously damaged.

(13) Governor arm damper. Check the governor arm damper assembly for free movement of the piston (87) within the barrel (88). Inspect for chipping of the piston and for scratches on the piston or barrel inside diameter. The bleed orifice in the barrel should permit free fuel flow when the piston is inserted. Replace individual components as necessary.

b. Repair.

(1) Replace transfer pump blades (67-70) if defective. Always replace both blades if one is defective.

(2) Replace all parts worn beyond allowable limits or found to be defective during inspection.

(3) During rebuild of pump, replace all springs, plungers, pistons, metering valve, vent wire, and cam roller and shoes, only if damaged.

14-45. Fuel Injection Pump Reassembly and Adjustment. Reassemble the fuel pump in the reverse order of the numerical sequence in figure 14-21 paying particular attention to the following.

a. All parts must be thoroughly flushed in clean oil as they are being reassembled. Cleanliness is most important. All seals and gaskets must be replaced, whether visibly damaged or not.

CAUTION

Install piston seal dry - do not use grease on the seal.

b. Insert regulating piston seal (56) into the lower end of the regulating sleeve assembly (57), far enough to expose retaining ring groove. Install retaining ring (53).

c. Rinse in clean oil and install regulating piston (55) and spring (54) into the sleeve, making sure that the piston slides to the bottom of the sleeve bore without binding.

CAUTION

Check for tightness of the orifice plate and replace adjusting plug if plate is found loose.

d. Install end plate adjusting plug (48), turning in until all threads are just below port "A".

e. Insert regulating sleeve assembly (57) into its bore in the end plate (59).

f. Fit the transfer pump thrust disk (63) to the end plate (59). The thrust disk may be reversed if one side appears worn or scratched. A small amount of grease will hold the disk in position during assembly.

g. Flush distributor rotor (142) in clean oil and assemble to the bore of the head with a slight rotary motion. Do not use force. Binding or stickiness indicates dirt. Remove rotor and rinse once more.

h. Flush the hydraulic head (144) and distributor rotor (142) thoroughly in clean oil and assemble, while immersed in oil, with a slight rotary motion. Under no circumstances should any force be used. Do not handle the rotor shank with the fingers.

i. Place the hydraulic head and rotor assembly (145) in the holding fixture. Insert the plungers (133, 134) and the leaf springs (127, 128). Insert the rollers and shoes and check for freedom of movement.

j. Install the centrality gauge, placing the indicator pin in the metering valve bore and securing with a head locking screw. Use a connector screw washer under the head of the screw. Loosen the dial indicator retaining screw and slide the indicator to its outer limit. Install head fitting hand tight and connect to a supply of clean, filtered, compressed air. Regulate the air pressure to 40-100 psi.

k. The correct roller-to-roller dimension is 1.977 ± .0005". Set both sets of rollers (129,130) as required adjusting each leaf spring (127,128) alternately. Since each roller shoe (131,132) for a given cylinder is controlled by a separate leaf spring, it may be necessary to invert or interchange leaf springs to obtain correct dimensions on both sets of rollers. Roller settings of both cylinders must be within .003" of each other.

l. Check centrality of the rollers (to assure that each one starts its pumping stroke at the same time) as follows: a) Rotate distributor rotor until one roller is aligned with dial indicator plunger. Slide indicator inward until plunger depresses at least .010". Lock indicator retaining screw. "Zero" indicator on high point of roller by rotating knurled dial. b) Rotate distributor rotor (either direction) until the next roller depresses dial indicator plunger. Allowable centrality is ± .002" (total .004"). Before making any correction, check and record centrality of all four rollers. c) If roller centrality is beyond specified tolerance, rollers and/or shoes can be interchanged. Recheck centrality after each change. Be sure to recheck roller-to-roller dimension as in step k above.

m. Place the cam ring atop the hydraulic head with the directional arrow pointing clockwise. Remember that pump rotation is always expressed as viewed from the drive end. The pump will not deliver fuel with incorrect assembly of the cam ring.

n. Place the governor weight retainer (123) in position over the drive on the distributor rotor. Make sure the assembly marks on the weight retainer and the distributor rotor line up with each other. Assemble the snap ring to its groove with the snap ring pliers.

o. While holding this assembly carefully together so the rotor will not fall out, invert the entire unit so that the governor weight retainer engages the bar on the holding fixture.

p. Install delivery valve (141) making sure that it operates freely in its bore. Install delivery valve spring (140) and a new delivery valve stop (139). The stop screw (138) internal hex has one end which is slightly relieved to clear the delivery valve stop. Be sure it faces down. Start the stop screw using the hex head end of the delivery valve extractor and finish tightening with a torque wrench to 85-90 inch-pounds.

q. Insert the two rotor retainers (120) by lifting the head up slightly so that the inside face of the head is flush with the rotor end. Position the retainers and install the retaining ring (119).

r. Insert the transfer pump liner (72) so that the large slot is in line with the head-locating screw hole, and the letter "C", which signifies pump rotation, faces up. This will correctly position the liner locating slot to accept the locating pin in the end plate.

s. Carefully place the transfer pump blades (67-70) in their slots in the transfer pump rotor. With one finger, rotate the liner several times to test for bind. Return the liner to correct position.

t. Insert the transfer pump seal (71) and mount the end plate (59) so that the inlet fitting is in line with the metering valve bore. The locating pin will now line up with the locating slot in the liner. If these are 180° out of alignment, check the end plate for correct location of the pin as to pump rotation (C is on the outside of the end plate). Fasten loosely with four screws (60) and washers (61, 62); do not ighten screws.

u. Slip the head and rotor assembly (145), drive end up, into open end of holding fixture. Place the six governor weights (116) in their sockets with the slots facing the bore of the assembly. Place the governor sleeve thrust washer (118) against the governor thrust sleeve (117) so that the chamfered edge faces the sleeve. Insert the forefinger into the bore of the sleeve and washer, holding them together, and insert them into the slots of the governor weights by tilting the weights slightly back. The tab on the thrust sleeve flange should face upward. Sight across the tops of the assembled weights to ascertain correct positioning. One weight higher than others indicates incorrect assembly of the thrust washer.

v. Place the governor arm (86) in position with the fork for the governor linkage hook facing the end plate. Insert the pivot shaft (85) (knife edge facing end plate) and assemble the two seals (83, 84) and cap nuts (81, 82). Tighten the cap nuts simultaneously to a torque of 35 to 40 inch-pounds.

w. The hydraulic head and rotor assembly (145), including the transfer pump, cam ring (122), governor weight retainer (123), weights (116), governor thrust sleeve (117), and washer (118), should now be assembled into the housing.

x. Cover shaft knurls with tape and install a new seal (143) on the hydraulic head. Rotate the cam ring so that the threaded hole is in line with the metering valve bore. This will insure proper position of the cam. Apply a light film of clean grease around the inside edge of the housing to aid in assembly.

y. Grasp the hydraulic head firmly in both hands and insert it into the housing bore with a slight rotary motion. Do not force.

z. If the assembly should cock during insertion, withdraw and start over. This is particularly important,as cocking can cause particles of metal to be shaved off the housing and left in the pump, causing serious damage in operation.

aa. When inserting, make sure the assembly is wrung into position past the hydraulic head seal (143). Failure to do this might cause damage to the seal, resulting in leakage. When the head and rotor are finally assembled in their approximate location, rotate them until the head locking screw holes line up with their corresponding holes in the housing. Insert the head locking screws (146, 147) finger tight.

ab. Invert the pump and holding fixture in the vise so the bottom faces upward.

ac. Insert and tighten the head locating screw (103).

ad. Install seals on piston plugs (96, 111).

ae. Install piston ring seal (106) and piston ring.

af. Assemble advance adjusting screw (112) (trimmer), advance spring (108) and spring washer (109).

ag. Place trimming screw (112) and spring assembly (108) in piston cavity (power side) and secure with retaining ring (110).

ah. Using the piston ring installing tool, slide power piston plug (96) over piston (99) until the advance adjusting screw (112) enters threaded hole in plug.

ai. Insert screwdriver into advance adjusting screw and turn out screw until approximately one half inch protrudes from plug. Do not turn plug on piston as piston ring damage may result.

aj. Slide assembled piston and plug into advance bore at "C" side of advance housing and thread plug until the cam pin bore is aligned with pin bore of cam.

ak. Install advance pin (102).

al. Place advance spring (108) into piston cavity and thread the spring side piston hole plug (111) into advance housing.

am. Tighten both plugs and install adjusting screw nut (114) and seal (113).

an. Turn the pump back to its original position (top upward) in the vise.

ao. Install the metering valve (93) and shims (95) into its bore. Depress and rotate the valve several times to insure freedom of movement. If valve sticks, lap it in carefully with clean oil. Never sand or polish off the special surface treatment provided.

ap. Pull back on the governor linkage hook (45), stretching the spring just enough to connect the hook correctly to the fork on the governor arm (86). Position the opposite end over the pin on the metering valve arm (91). Check all of the governor parts again for freedom of movement.

aq. With end plate removed (59), assemble the speed droop control rod assembly (79) through threaded hole from inside of pump housing.

ar. Slide speed droop guide (75) with O-ring seal (77) assembled over end of rod (79) and thread into rear of housing. Do not overtighten; allow 0.010" clearance between guide (75) and pump housing face.

as. Insert clip (78) into hole at end of rod (79).

at. Assemble seal (74) to groove at end of guide (75) and adjust speed droop cap assembly (73) over seal.

au. Install end plate making certain locating pin enters slot in transfer pump liner. Assemble flat (61) and lock (62) washers four end plate screws (60) and tighten to 35 inch-pounds.

av. Thread five full turns of spring (80) onto speed droop rod assembly (79). Slip free end of spring (80) over formed ends of governor arm (86) with the bent-in ends of the spring between the two tabs.

NOTE

> The apparent looseness in the governor parts is normal. Lost motion is immediately taken up as soon as the pump rotates.

aw. Assemble the throttle shaft assembly (26) and lever assembly (32) partially through its bore in the housing. Slide the spacer bushing (38) and throttle shaft lever (40) over the throttle shaft so that the projection on the throttle shaft lever bore engages the keyway on the shaft. Position the forked end of the throttle lever so that it straddles the guide stud. Apply a light coat of grease to the throttle and shut-off shaft seals (35, 36). Assemble the shut-off shaft assembly (24) from the opposite side with a slight rotary motion. So as not to damage the seal, firmly seat the two levers. Locate and seat the shut-off cam (25).

ax. With the throttle lever in wide open position, check the clearance between the rear of the shut-off shaft (B) and the vertical tab (A) on the linkage hook. This clearance should be 0.250 inch. (See figure 14-22)

NOTE

> Adjustment of this clearance in the pump is made by changing the effective length of linkage hook.

ay. With adjusting screw (C) tight, apply a slight pressure to tab (A). At the same time rotate pump one or two complete revolutions to assure that linkage is in full forward position. Loosen adjusting screw (C) and slide linkage to maximum open length. Insert linkage gauge between vertical tab (A) and shut-off shaft (B) and slide linkage hook together from rear until face of tab is flush against gauge. Tighten adjusting screw (C). Check adjustment and reset if required.

az. Check all governor parts for freedom of movement. Assemble a new seal (6) to cover (4), and install cover on pump, tightening the three retaining screws (1) securely.

14-46. Solenoid Inspection and Repair.

a. Crank engine and check for 24 Vdc across solenoid leads on top of injection pump.

b. If voltage exists, loosen an injector coupling and check for full line of fuel. If fuel is not available, solenoid has failed.

c. Remove the cover contact nuts (7, 8) and washers (9, 10) and work the solenoid assembly out of the cover. Remove the shut-off spring (13) guide (14), and arm (15).

d. Examine the solenoid visually for cracks and swelling in the encapsulating material and looseness

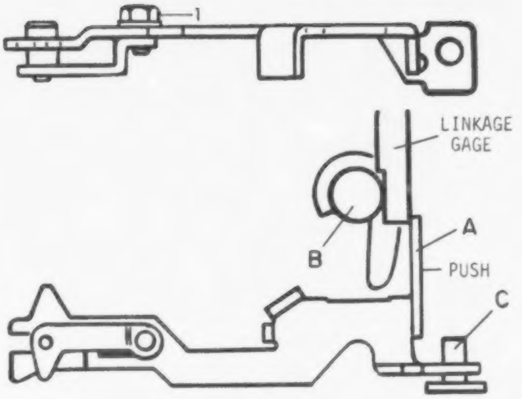

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Figure 14-22. Throttle Linkage Adjustment

of the contact screws. Check the solenoid for a complete circuit with an ohmmeter.

e. Assemble the shut-off arm (15) and spring (13) and guide (14) to the coil. Before installation of the solenoid assembly to the cover is made, adjustment of the arm travel and spring tension should be carried out as illustrated in figure 14-23. Install new insulating tubes (11, 12) to both contact screws. Insert the assembly into the governor control cover as a unit. Replace the insulating washer (10) and assemble the contact nuts (7, 8) (20-25 inch-pounds). Mount the cover assembly, with new cover seal (6), to the pump and tighten securely.

f. With the pump mounted on the test bench, the electrical shut-off device must be checked with 24 Vdc and wide open throttle at the following speeds:

(1) 400 rpm

(2) Full load governed speed

(3) High idle (shut-off only)

NOTE

If use of automotive type batteries is impractical, a good, heavy duty battery charger can be used as long as voltage can be selected and will hold with minimum drop (1/2 volt max.) during application to the solenoid coil. Use of small, inexpensive trickle chargers is not recommended, since a voltage drop of 2-3 volts can be expected when current is applied to the coil. This can result in questionable operation and rejection of good coils under some conditions. Do not attempt to check solenoid operation with the cover removed from the pump. The governor linkage spring aids operation when the cover is assembled.

g. Reassemble solenoid.

h. Install solenoid on fuel injection pump.

i. On equipment test. Energize solenoid with 24 Vdc. If a clicking sound is heard, then the solenoid is operating.

14-47. Variable Speed Droop Device.

a. Remove the cover, shut-off cam, shut-off shaft assembly, throttle shaft assembly, throttle shaft lever, and governor linkage hook. Remove end plate assembly.

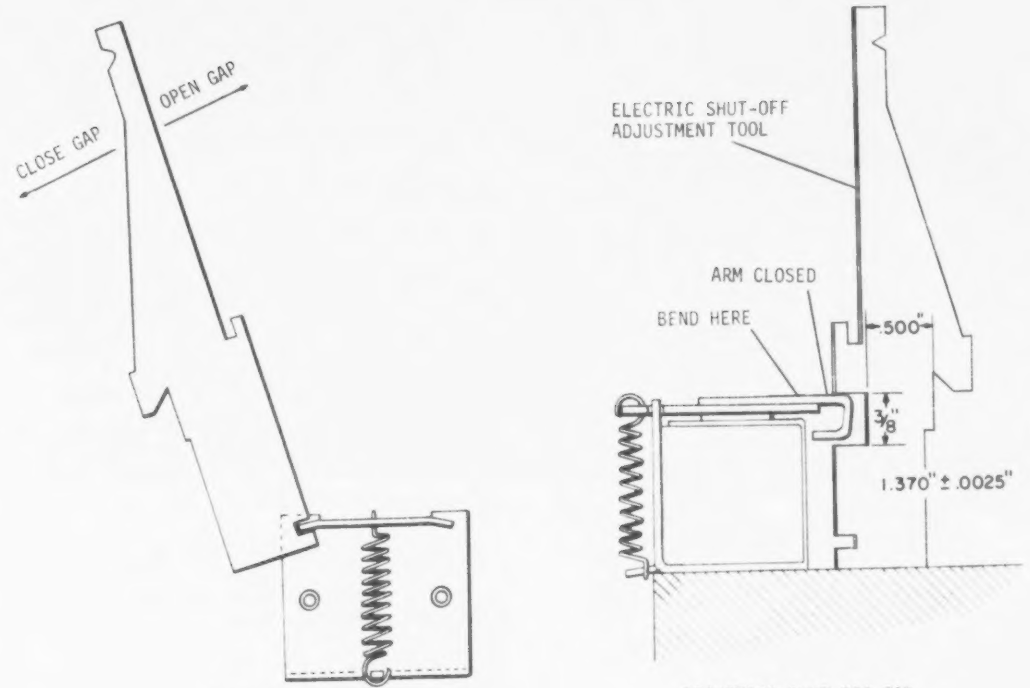
b. Remove the adjusting cap (8, fig. 14-24) by pulling to the rear of the pump. With a pair of needle-nose pliers, remove the control rod clip (4). Do not bend the control rod. Loosen and remove the control rod guide (6), "O" ring (5) and guide washer (15). Disengage the governor spring (2) from the governor arm (1) and remove the governor spring and control rod assembly as a unit.

c. Examine the governor spring for distortion and the spring guide and bushing for excessive wear. Replace the two seals on the control rod guide. Check control rod for straightness and replace, if needed.

d. Insert the control rod assembly (3) through the threaded hole from the inside of the housing. Slide the control rod guide (6), O ring (5) and guide (9) over the end of the control rod (3), and thread into housing. Tighten securely. Insert clip (4) into the control rod end being careful not to bend the rod. Slide the adjusting cap (8) over the new seal on guide (6). Thread five full turns of governor spring (2) onto the spring guide (9) with the spring guide and bushing (10) against each other as shown in figure 14-24. Slip the free end of the governor spring over the formed ends of the governor arm (1) with the bent end of spring between the two tabs.

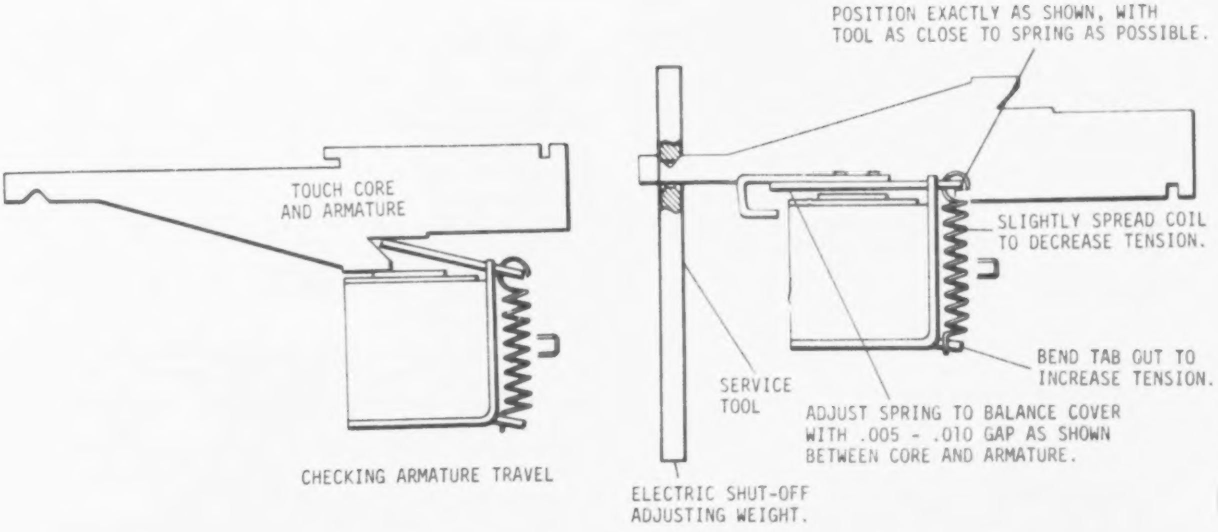
e. Install the end plate, throttle shaft assembly, throttle shaft lever, shut-off shaft assembly, and shut-off cam. Adjust low idle adjusting screw so bushing (10) just touches rod guide and forked end of throttle shaft lever straddles and engages flats on bushing. Replace cover. The speed droop assembly is now positioned for minimum droop.

f. During bench test, make normal check of output, metering and transfer pump pressure at full load governed speed as called for in paragraph 14-48. High idle adjusting screw should be backed all the way out and throttle held open as far as possible. Refer to paragraph 14-48 for bench test of fuel injection pump. See figure 14-24 while making adjustments on speed droop.


OPEN GAP
CLOSE GAP
ELECTRIC SHUT-OFF
ADJUSTMENT TOOL
ARM CLOSED
BEND HERE
.500"
3/8"
1.370" ± .0025"

ADJUSTING ARMATURE TRAVEL

ADJUSTING SHUT-OFF TAB


TOUCH CORE
AND ARMATURE
POSITION EXACTLY AS SHOWN, WITH
TOOL AS CLOSE TO SPRING AS POSSIBLE.
SLIGHTLY SPREAD COIL
TO DECREASE TENSION.
BEND TAB OUT TO
INCREASE TENSION.
SERVICE
TOOL
ADJUST SPRING TO BALANCE COVER
WITH .005 - .010 GAP AS SHOWN
BETWEEN CORE AND ARMATURE.
ELECTRIC SHUT-OFF
ADJUSTING WEIGHT.

CHECKING ARMATURE TRAVEL

ADJUSTING ARMATURE SPRING TENSION

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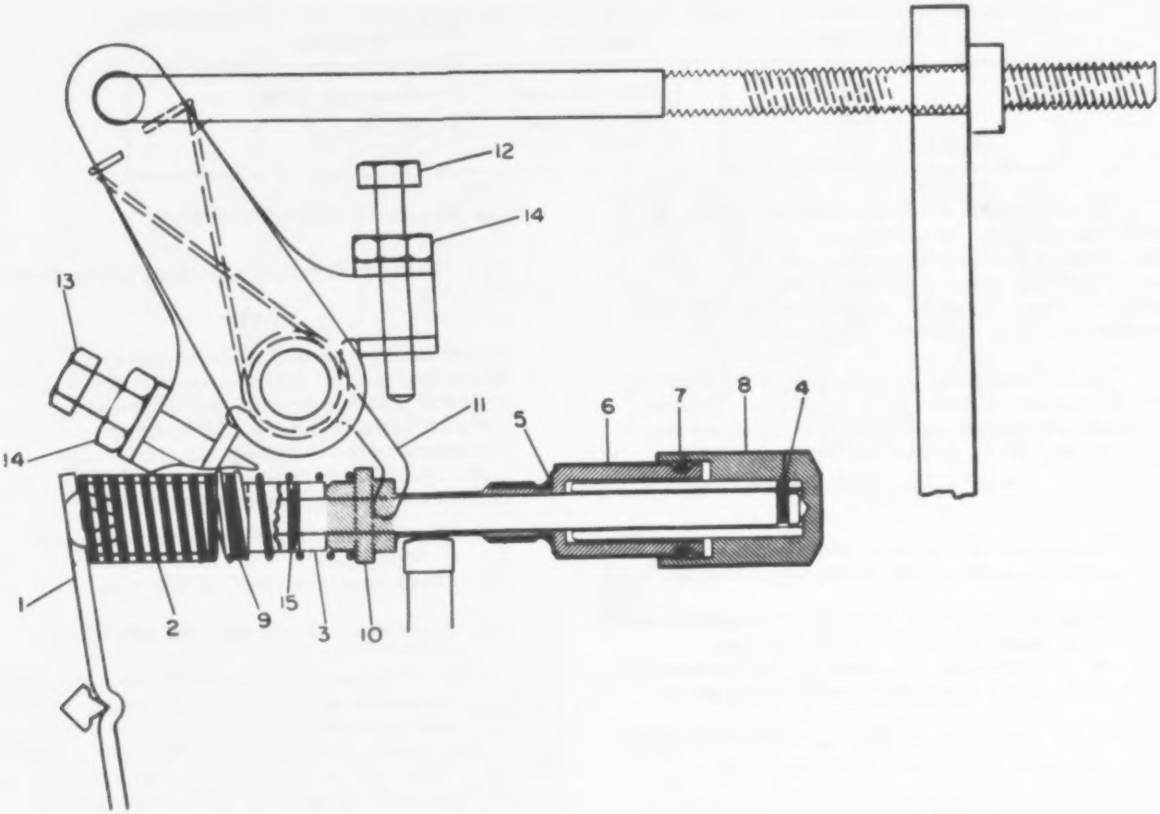
Figure 14-23. Solenoid Armature Adjustments



1. Governor arm
2. Governor spring
3. Control rod assembly
4. Control rod clip
5. O-ring
6. Control rod guide
7. O-ring
8. Adjusting cap
9. Spring guide
10. Bushing
11. Throttle shaft lever
12. High speed adjusting screw
13. Idle adjusting screw
14. Locknut
15. Guide washer

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Figure 14-24. Variable speed droop adjustment

14-48. Fuel Injection Pump, Bench Test.

a. The following bench test procedure is based on the following conditions.

(1) Injection lines. Two standard line sizes; 1/16 inch I. D. by 20 inches and 3/32 inch I. D. by 20 inches long.

(2) Fuel. The readings are based on fuel with a viscosity of 34-36 SSU at 100° F.

(3) Fuel Temperature. 110 - 115° F.

(4) Nozzles: part number 12SD12 adjusted to an opening pressure of 2500 psi (175 ATS).

b. Use diesel injector pump test stand and proceed as follows:

(1) Mount the pump securely with a suitable adapter. A drive adapter, usually with a ball bearing, supports the shaft. This pump must be tested using an intermediate support bearing. Install high pressure injection lines using new gaskets. Leave fuel line connector screws at pump and injection line nuts at nozzles loose. Install inlet and return lines and transfer pump pressure gauge. Use a restriction fitting on the return line. The pump comes with one installed.

(2) Set counter and tachometer switches to clockwise position. Remember that the test stand tachometer registers pump speed.

Table 14-2. Fuel Delivery

| Pump rpm | Delivery | Pressure |
|---|---|---|
| 900 | 113-118 $mm^3$ | 60-65 psi (hold) |
| 600 | 121-126 $mm^3$ | 45-50 |
| (high idle) 918 | 15-17 $mm^3$ | - |

(3) Start stand at lowest speed and check for clockwise rotation. Move throttle to full-load position. When transfer pump picks up suction, allow fuel to bleed for several seconds from loosened connector screws. Likewise, allow fuel to bleed from loosened injection line nuts. Tighten securely.

(4) Operate pump at 500 rpm for 10 minutes. Dry off completely with compressed air. Observe for leaks and correct as necessary. Back out the high idle stop screw and torque screw.

NOTE

The inlet to the transfer pump should never be pressurized during bench testing.

(5) Close valve in supply line - transfer pump must pull at least 18 inches hg at 200 rpm. If it does not, check for air leaks on suction side or malfunction of end plate and transfer pump parts.

(6) Fill graduates to bleed air from test stand and to wet glass.

(7) Observe return oil. Return should be at rate of 100-450 cc/minute at 35 psi transfer pump pressure.

CAUTION

Under no circumstances should 130 psi be exceeded, as the pump will be damaged.

(8) Operate at the 900 rpm with wide open throttle and observe transfer pump pressure. Adjust pressure-regulating spring plug to raise or lower transfer pump pressure.

(9) Check for minimum delivery at cranking speed of 75 rpm. The delivery rate should be a minimum of 65 $mm^3/s$ at a minimum of 8 psi.

(10) Operate at 918 rpm. and adjust high idle screw to obtain 20-25 percent of full-load fuel delivery.

(11) Adjust the low idle screw, if used, to a low idle delivery of 10-12 cc/1000 strokes at 500 rpm.

(12) Check the cam position at specified points in the speed range given in table 14-2. Attain all speeds by first running at a higher rpm, then reduce to normal operation speed. Adjust trimmer screw, or shim, as required, to obtain proper advance operation. Each mark on the timing window is 2 pump degrees (4 engine degrees).

(13) Record fuel delivery at check points shown in table 14-2.

NOTE

Roller settings should not be readjusted on the test bench. Micrometer and dial indicator settings provide more consistent, accurate results in performance. Variations in test benches, nozzles, lines, and fuels in different areas sometime result in inaccurate flow readings.

(14) Recheck delivery at 900 rpm checkpoint.

(15) Check governor cutoff at 950 rpm.

(16) Speed droop device test and adjustment.

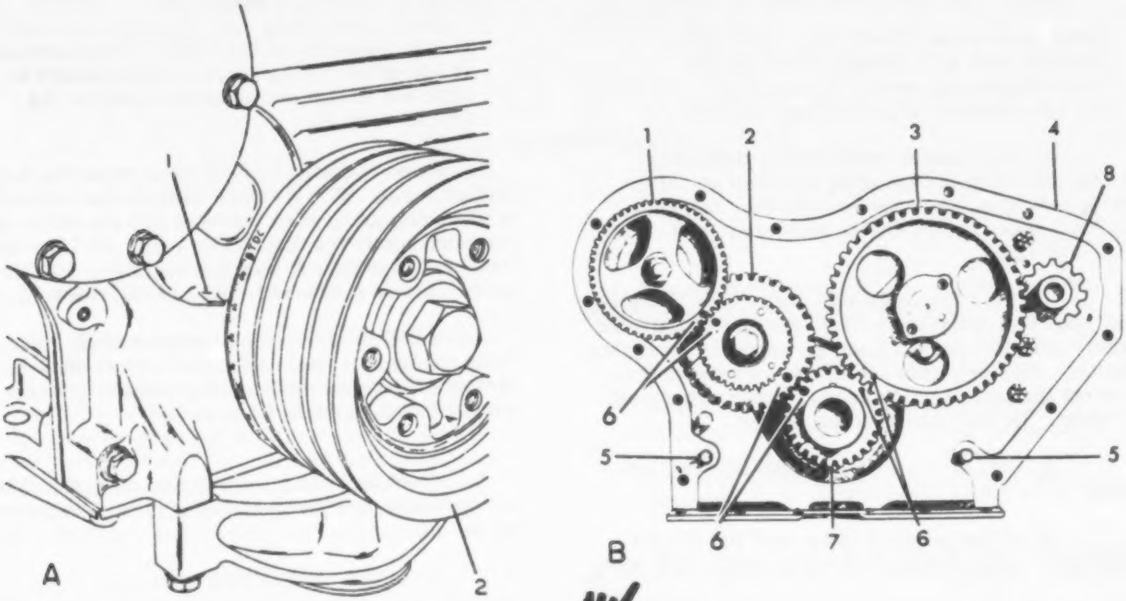
(a) After normal pump test, check full-load governor regulation by moving the throttle lever toward the closed position until the pump is "on governor" at full-load speed. 1800 (60 Hz), 1500 (50 Hz), 2000 (400 Hz). This will be indicated by a difference in delivery sound and a slight reduction of fuel delivery (1-2cc/1000 strokes) when a "draw" is taken into the graduates. Hold the throttle in this position with the standard vernier rack positioner supplied with most test benches. Do not position throttle by means of high-speed adjusting screw.

(b) Increase test stand speed. Record speed where fuel delivery falls to 116-120 cubic millimeters per stroke (1500 rpm or 50 Hz) or 114-118 cubic millimeters per stroke (1800 rpm or 60 Hz). This speed is known as no-load speed and should not be higher than the percentage or the high idle speed 1836 rpm (60 Hz), 1545 rpm (50 Hz). If, for example, the unit operates at 1500 rpm full-load and 3 percent regulation is required, no-load speed will be:

$$1500 \times 0.03 = 45$$
$$1500 + 45 = 1545$$

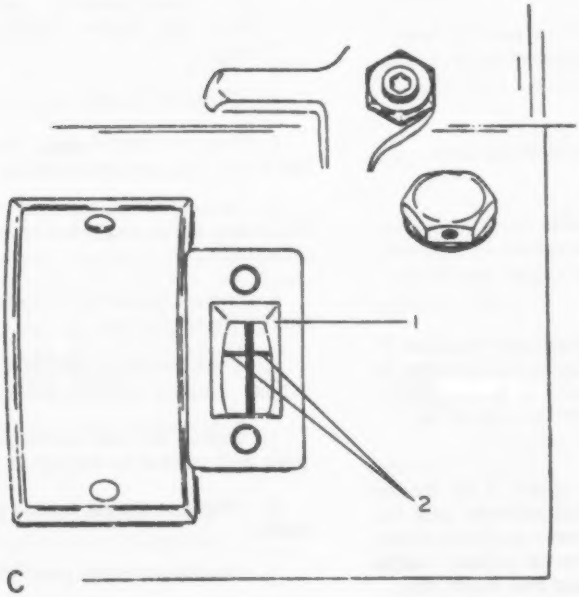
At 1545 rpm, the pump should not deliver more than 116-120 cubic millimeters per stroke at 50 Hz; 114-118 cubic millimeters per stroke at 60 Hz.

(c) If high idle, no load speed, as described above, is too low, adjust by means of the knurled knob at the rear of the pump housing. This is the droop adjustment. The knob should be turned clockwise to raise the no-load speed 1836 rpm (60 Hz); 1545 rpm (50 Hz).



1. Timing pointer
2. Crankshaft pulley and dampener assembly

1. Fuel injection pump drive gear
2. Idler gear
3. Camshaft drive gear
4. Front support plate
5. Dowel pin
6. Timing marks
7. Crankshaft gear
8. Hydraulic oil pump drive gear



1. Timing window
2. Timing marks

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Figure 14-25. Fuel Pump and Engine Timing

NOTE

After each droop adjustment, check full-load delivery and reposition the throttle lever slightly as needed to compensate for any change in full-load fuel delivery.

(d) Disconnect vernier rack positioner. Hold throttle lever as far open as it will go with high-speed adjusting screw backed out. Increase test stand speed to 10 percent above full-load speed (900 rpm).

(e) Turn high idle adjusting screw in (clockwise) until fuel delivery is 20-25 percent of full-load quantity (900-990 rpm). Lock adjusting screw in this position. This prevents accidental overspeeding in the event that speed droop needs further adjustment on engine. Do not change droop setting.

(f) Seal all throttle and shut-off lever adjusting screws with lead plomb.

(g) If fuel pump is to be used for 400 Hz application, reset high idle speed screw to 1125 rpm.

(17) Speed droop adjustment installed on engine (60 HZ application).

(a) After priming fuel system, start and warm engine to operating temperature.

(b) With full-load applied and engine operating at rated speed, droop may be determined by removing load and noting no-load speed or frequency.

(c) Droop may be adjusted by turning knob clockwise to increase, counterclockwise to decrease. A minor correction of throttle position will also be necessary.

### 14-49. Fuel Pump Installation, Fuel Pump and Engine Timing.

a. Insure that the number 1 piston is on its compression stroke. This can be determined by removal of the cylinder head cover so valve action can be observed.

(1) Bar the engine over by hand until number 6 cylinder exhaust valve is nearly closed and number 6 cylinder intake valve is just beginning to open. This will position number 1 cylinder near the top of its compression stroke.

(2) To be sure that all slack is out of the timing gears, back up the engine (counter clockwise) past the 24° BTDC timing mark and again come up to the timing mark (24° BTDC) in the direction of normal engine rotation (clockwise when viewed from the front) (fig. 14-25, View A).

NOTE

During assembly of the engine or replacement of any of the timing gears it is necessary to align the timing marks as indicated in (fig. 14-25, View B).

b. Remove timing window cover from the fuel injection pump. With a clean, wide bladed screwdriver or the pump drive shaft inserted into the drive end of the pump rotate the distributor rotor until the timing line on the weight retainer hub registers with the line on the cam as indicated in (fig. 14-25, View C).

c. Install drive shaft by greasing shaft seals with clean grease. Do not roll seals over as shaft is inserted into pump. Slot in pump end of shaft should mate with tab on pump rotor pin.

d. Mount fuel pump and adapter in position on engine and secure pump and adapter with mounting bolts.

*NOTE*

***New injection pumps received from supply have a high idle adjustment of 1860 rpm for 60HZ applications. Installation on 400HZ generator sets requires resetting the high speed adjustment screw (12, figure 14-24) to 2250 rpm. Adjustment is accomplished using an engine speed tachometer, with actuater rod (3, figure 13-1) disconnected, the shutoff lever, (21, figure 14-21) in the on-fuel condition, then manually operating the throttle lever, (32, figure 14-21) against high speed stop.***

e. Connect throttle and shut-off linkage.

f. Connect fuel supply, return, nozzle leak-off lines and high pressure lines.

g. Before installing fuel pump drive gear, inspect fuel pump drive shaft and remove any burrs if necessary.

h. Install woodruff key and coat fuel pump drive shaft with engine oil.

i. Position fuel pump drive gear on shaft so keyway in gear lines up with the woodruff key.

j. Install nut and lockwasher to secure drive gear and tighten to torque of 35 to 40 foot-pounds.

k. Replace thrust button and spring on drive shaft.

l. Replace timing gear inspection cover.

### 14-50. Equipment Test.

If the fuel injection pump has been repaired or replaced refer to Chapter 16, Section II and conduct the following equipment tests.

a. Frequency and voltage regulation, stability, and transient response test, short term. Refer to paragraph 16-15.

b. Frequency adjustment range test. Refer to paragraph 16-16.

## Section IX. TURBOCHARGER

### 14-51. General.

a. The turbocharger is an exhaust driven blower used to boost the power output of an engine over that of a naturally aspirated engine by increasing the supply of air to the cylinders. The turbocharger incorporates a single stage radial inflow turbine wheel, mounted on a common shaft with a single stage centrifugal compressor impeller. It has a one-piece center housing with floating sleever type bearings, a turbine housing, and a compressor housing.

b. The turbocharger responds to engine load demands by reacting to the flow of expanding exhuast gases and supplying a correlated volume of air to the engine cylinders. During a heavy load/lugging operation, the increased flow of exhaust gases turns the turbine wheel faster, causing the compressor impeller to turn faster to supply more air to the intake manifold. Conversely, when engine load is light and the radial flow of gases within the turbine decreases, the turbocharger compressor reduces the supply of air to the intake manifold.

c. The turbocharger bearings are lubricated and cooled by filtered engine oil circulating through the center housing under normal oil pump pressure. This oil is supplied to the center housing through an external line through the engine main oil filter. Oil returns to the crankcase through an external line which extends from the bearing housing to the side of the cylinder block.

d. The turbine of the turbocharger is part of the exhaust system. The exhaust manifold on a turbocharged engine is in three sections with the front and the rear sections inserted into the center section. The manifold is sealed to the exhaust parts of the cylinder head with a steel gasket and secured in place with capscrews and lock washers.

### 14-52. Turbocharger Removal and Disassembly.

CAUTION

While turbocharger is off engine, keep all manifold openings covered to prevent entry of foreign objects.

a. Refer to Operator and Organizational Maintenance Manual for symptoms and isolation of malfunction of the turbocharger.

b. Refer to Operator and Organizational Maintenance Manual and remove turbocharger.

c. Disassemble turbocharger in the numerical sequence illustrated in figure 14-26.

CAUTION

Do not rest the center housing with the included stationary and rotating parts on the compressor impeller. Weight of the complete assembly will damage the impeller blades.

d. Mark the relative positions of the compressor and turbine housings to the center housing to facilitate reassembly.

e. Apply penetrating oil, or diesel fuel, to the bolts that secure the turbine housing and backplate to the center housing.

f. Remove the compressor housing. If necessary, tap the housing lightly with a soft hammer to loosen it. Remove the diffuser (3).

g. Record the shaft radial movement and shaft end play.

(1) Check shaft end play as follows: (Specified end play .001" to .0042".

(a) Clamp the turbine housing flange in a vise.

(b) Use either a clamp or magnetic base dial indicator.

(c) Place indicator contact point on end of impeller shaft.

(d) Press up on turbine wheel to force the impeller to extreme up position; record indicator reading.

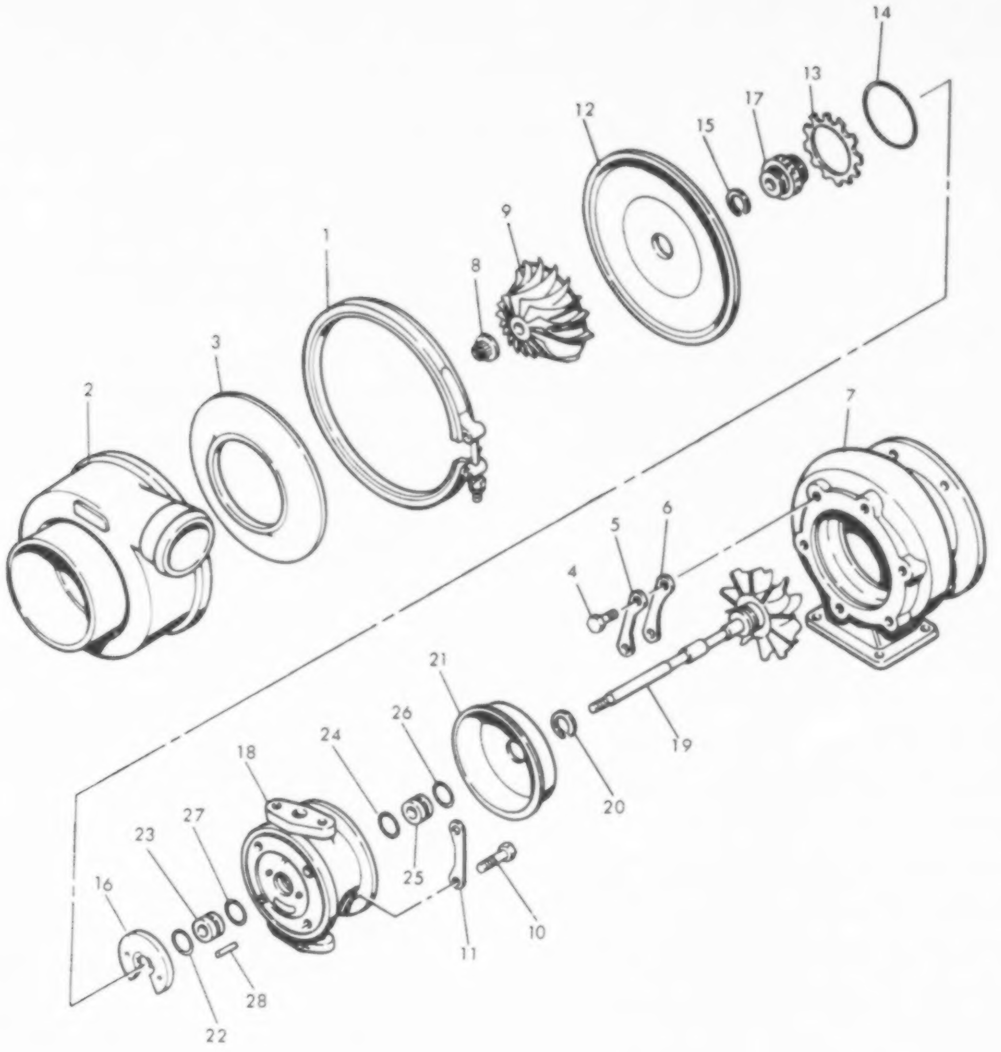
(e) Press down on impeller; again record indicator reading.

(f) The difference between the readings is the end play.

(g) End play should be from .001" to .0042".

(h) Record the end play. This will be used to determine if thrust plate assembly or thrust bearing need to be replaced.

(i) If end play exceeds .0042", it indicates


14
13
17
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12
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1
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3
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7
5
6
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21
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23
16
25
10
11
28
22

1. V-band clamp
2. Compressor housing
3. Diffuser
4. Bolt
5. Lockplate
6. Clamp
7. Turbine housing
8. Locknut
9. Compressor impeller
10. Bolt
11. Lockplate
12. Backplate
13. Spring washer
14. Ring
15. Ring
16. Thrust collar
17. Thrust bearing
18. Center housing
19. Shaft assy
20. Ring
21. Shroud
22. Bearing retainer
23. Bearing
24. Bearing retainer
25. Bearing
26. Bearing retainer
27. Bearing retainer
28. Pin

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Figure 14-26. Turbocharger Assembly

that thrust collar thrust bearing, or thrust bearing surface of the back plate assembly are worn. If end play is less than .001", it indicates a carbon build-up behind the turbine wheel. Unit must be disassembled and condition corrected.

(2) Check the shaft radial movement (specified radial movement is .003" to .007"). Proceed as follows:

(a) Attach a dial indicator adapter to the oil discharge outlet, or fabricate an adapter by threading the end of a rod approximately 8" long. Secure the rod to the turbine housing. Attach the dial indicator with appropriate extensions to the adapter.

(b) Position the point of the dial indicator, through the oil discharge outlet, on the center of the impeller shaft.

(c) With one hand on the compressor impeller and one hand on the turbine wheel, pull the shaft up against the indicator. Record the indicator reading.

(d) With one hand on the impeller and one hand on the turbine wheel, push the shaft down, away from the indicator. Record the indicator reading.

(e) The difference between the readings recorded in steps (c) and (d) will be the total shaft radial movement. Repeat the procedure several times before accepting a final figure.

(f) If the radial shaft movement exceeds .007", it is an indication of shaft or bearing wear, or that the bearing bore in the center housing is worn. The unit must then be disassembled and reconditioned.

h. Use a sliding "T" handle and a 3/8 inch, 12 point socket and remove the locknut (8). Hold the "T" handle at the ends to prevent bending of the shaft.

i. Twist and pull up to remove the compressor impeller (9).

j. Remove the metallic seal ring from the groove on the turbine impeller shaft.

k. Remove the thrust bearing (17) and thrust collar (16) as a unit. Separate bearing and collar.

l. Remove the metallic sealing ring (20) from the thrust collar (16)

NOTE

Since the outer bearing retainers and bearings may be removed from either end of the center housing, it is not necessary to remove inner bearing retainers unless inspection reveals them to be damaged or unseated. Always replace bearing retainers.

m. Remove outer bearing retainers with a sharp pointed tool such as an ice pick; use a twisting motion. Use care to avoid scoring bearing or bearing bore.

14-53. Turbocharger Cleaning and Inspection.

Refer to Operator and Organizational Maintenance Manual.

14-54. Turbocharger Repair.

a. If the turbocharger is damaged due to lack of lubrication and results in bearing seizure, or if the impellers are damaged due to foreign objects passing through the turbine or compressor, the damage will be extensive and require replacement of the rotating parts and possibly the replacement of the center housing. This must be determined by inspection. At the time of engine overhaul the turbocharger must be disassembled and all parts inspected.

b. Burnish or polish out minor surface damage using silicon carbide abrasive cloth for aluminum parts and crocus cloth for steel parts; clean before reassembling with cleaning solvent Federal Specification P-D-680.

c. At time of repair or overhaul, replace rubber seal ring, metallic seal rings, bearing retainers, and lock plates.

d. Make certain all parts are thoroughly clean and work bench area is clean and free of any abrasive material before proceeding with inspection of individual parts.

e. Replace bearings if they indicate signs of scoring, nicks, shellac-like deposits, or other foreign matter. Use a micrometer and telescoping gauge and measure the diameters. The bore of the impeller shaft bearings must not exceed 0.4019 inch and the outer diameter must not be less than 0.6182 inch. Replace bearings at time of overhaul.

f. The thrust bearing must not show any signs of scoring or foreign matter deposit on the grooved side. Measure the thickness at three places along the collar bore. The measurement must not be more than 0.1720 or less than 0.1711 inch. Replace the thrust bearing at time of overhaul.

g. The bore for the metallic seal ring must not indicate signs of scoring or roughness. The seal bore must be clean and smooth. The size of the bore must not exceed 0.5015 inch. Replace if this measurement is exceeded.

h. Make certain that the turbine and compressor housing are clean and have no internal obstructions that could impede the flow of gases. Replace damaged housing.

i. The compressor impeller must not show any signs of rubbing with either the compressor housing or the backplate. The bore must be smooth. The fit should be 0.0002 inch to 0.0004 inch. The blades must be totally free of dirt or any other foreign substance. The blades must not be bent, cracked, or eroded to a feather edge. Replace compressor impeller if these requirements are not met.

j. Oil passages in the thrust collar must be open and clean. The thrust faces must not be warped or scored. The ring groove shoulders must be free of step wear. The bearing area width should not exceed 0.1758 inch. The ring groove width must not exceed 0.0665 inch. Check the clearance between the thrust collar and the thrust bearing with a feeler gauge. Clearance should be between 0.001 and 0.004 inch at three spots. Replace thrust collar if requirements are not met.

k. Inspect the shroud for cracks, signs of erosion, damage caused by rubbing, and distortion. Replace shroud if damaged.

l. The turbine wheel must not reveal any signs of rubbing and the vanes must not be cracked, nicked, or eroded to a feather edge. The shaft must not show any signs of scoring, scratching or overheating. Use a micrometer to measure the shaft journals. Replace turbine wheel and shaft if damaged. The journals must not be more than 0.003 inch out of round, and the diameter must not be less than 0.3992 inch. The sealing ring groove walls must be free of step wear. The sealing ring hub outer diameter is 0.682 to 0.683 inch. Ring groove width is 0.0645 to 0.0665 inch. Replace excessively worn journal.

### 14-55. Turbocharger Reassembly and Installation.

NOTE

> The tools and workbench must be kept clean at all times during the reassembly to prevent the entrance of dirt or foreign matter. All parts must be free of nicks, burrs, scoring, and foreign matter.

a. If the inner bearing retainers have been removed from the center housing, install new retainers.

b. Place the center housing on end on the bench.

c. Oil one of the bearings and place it against the inner bearing retainer.

d. Install the outer bearing retainer.

e. Invert the center housing and install the remaining bearing and retainer in the same manner.

f. Insert the turbine and shaft assembly, with new metallic seal installed, into a suitable holding fixture.

g. Place the turbine shroud on the shaft.

h. Oil the shaft journals. Apply a light, even coat of oil.

i. Place the center housing assembly over the shaft. Press down to seat the metallic seal ring. Rotate the housing to assure proper seating.

j. Install a new metallic seal on the thrust collar.

k. Insert the thrust collar in the thrust bearing so that the metallic seal ring end of the collar is on the smooth side of the thrust bearing.

l. Install the thrust bearing and collar assembly. Place the thrust bearing over the pins on the center housing. The bearing will fit only one way. Press down to seat.

m. Install a new rubber seal ring.

n. Make certain the thrust spring is installed in the backplate.

o. Install the backplate. Use care not to damage the metallic sealing ring on the thrust collar. Install the lockplates. Tighten the bolts to 40-60 inch-pounds torque. Bend up the locking tabs.

p. Install the compressor impeller. Use a twisting motion to insure that the impeller bottoms on the thrust collar.

q. Washer face of locknut and the face of the impeller must be smooth and clean. Lightly oil the threads and washer face of the locknut. Install locknut; tighten to 18-20 inch-pounds. Use a sliding "T" handle and further tighten locknut through another 90 degrees.

r. Install the turbine housing, clamps and lockplates. Tighten the bolts to 100-130 inch-pounds. Bend up locking tabs.

s. Refer to the Operator and Organizational Maintenance Manual and install the diffuser.

t. Install the compressor housing.

u. Install the V-band clamp. Tighten nut to 40-80 inch-pounds.

v. Refer to Operator and Organizational Maintenance Manual for installation of the turbocharger.

## Section X. WATER PUMP AND FAN

### 14-56. General.

a. The water pump is a centrifugal type pump that circulates coolant through the engine and radiator. The pump is mounted on the front of the cylinder block and is belt driven from the crankshaft pulley. Coolant is drawn through the inlet opening by the pump impeller and forced through the outlet in the backside of the volute and into the cylinder block, and the lube oil cooler.

b. The water pump shaft and bearing assembly does not require lubrication because the bearing is of the sealed-for-life type. A water slinger on the pulley end of the shaft slings any coolant which might seep past the seal assembly out the cored opening in the pump body, thus preventing coolant from coming in contact with the shaft bearing. The shaft and bearing assembly is secured in the pump body by a press fit and a retaining snap ring. The seal between the impeller and pump body is of the packless type. The seal assembly is spring loaded and is pressed into the pump body forming a leakproof seal at this point.

c. The fan is located behind the radiator on the front of the engine. The fan is belt driven from the engine and draws cooling air through the louvered panel at the rear of the unit and exhausts it through the radiator core, shutter and grille.

### 14-57. Removal and Disassembly.

a. Water Pump Removal.

Refer to Operator and Organizational Maintenance Manual.

b. Fan Removal.

Refer to Operator and Organizational Maintenance Manual.

c. Water Pump Disassembly.

(1) Place water pump in a press and remove pulley hub.

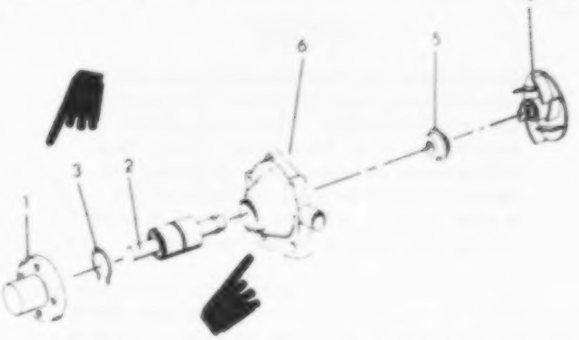
(2) See figure 14-27 and disassemble water pump as illustrated.

(3) Place water pump assembly in position on a press, impeller end up. Make certain the pump rests on back of pump body and not on the water inlet or drain hole. Press end of shaft until shaft and bearing assembly is out of the pump body. Remove impeller from the pump body.

(4) Drive out seal assembly with a drift pin or rod and a hammer.,

### 14-58. Inspection and Repair.

a. Check condition of pump shaft and bearing assembly by rotating the bearing. If the bearing is binding, running dry from lack of lubricant, or feels rough, the shaft and bearing assembly must be replaced. If the slinger is damaged, it must be replaced.



■ 1. Hub
2. Bearing-shaft assy
3. Flinger
4. Impeller assy
5. Seal assy
■ 6. Body

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Figure 14-27. Water Pump

CAUTION

Do not clean shaft and bearing assembly in cleaning solvent because the lubricant will be washed from the bearing.

b. Check condition of the ceramic seal insert bonded to the pump impeller. If it is rough, cracked, or chipped, replace the impeller.

c. Thoroughly clean pump body with cleaning solvent, Federal Specification P-D-680.

d. Check condition of bearing bore in the body. Replace pump body if cracks are evident.

e. Replace the water pump seal assembly.

### 14-59. Reassembly and Installation.

a. Pump Reassembly.

(1) Position pump body on press, impeller end up. Position seal assembly in the pump body. Place seal installer tool on the seal and press seal into pump body, making certain the carbon sealing surface is not damaged.

CAUTION

Face of seal assembly must be free of oil, grease, and fingerprints before seal assembly is installed.

(2) Position pump body on press, bearing bore up. Start shaft and bearing assembly into bore, slinger end of shaft down. Press shaft until bearing seats on shoulder in the pump body. The slinger must be 1-15/16 inches from the end of the shaft

before installing in the pump body.

CAUTION

Do not force the bearing shaft assembly into the pump body by putting pressure on the end of the shaft. Use a tool which puts the force on the outside race. This will prevent the possibility of pitting the races of the bearing by the balls within it when more force than required is used to seat the bearing in the pump body.

(3) Position pump on press with pulley hub end of shaft firmly supported on the press base plate. Position impeller on upper end of shaft. Using a collar between the impeller and the press ram, press impeller on shaft to attain 0.015 inch maximum feeler gage clearance between impeller and body.

CAUTION

Seal face of impeller must be free of oil, grease, and fingerprints before installing impeller.

(4) Position water pump on a press with the impeller end of the shaft firmly supported on the press base plate. Use a collar between pulley hub and press ram because the end of the shaft protrudes beyond pulley hub; press pulley hub on shaft to within four inches (± 0.010 inch) between bottom of pump body and the fan side on the pulley hub flange.

(5) Rotate pulley hub and check for proper operation of the water pump assembly.

NOTE

A slight drag caused by mating surfaces of the seal assembly and impeller is normal.

b. Pump Installation.

Refer to Operator and Organizational Maintenance Manual.

c. Fan Installation.

Refer to Operator and Organizational Maintenance Manual.

## Section XI. CRANKSHAFT PULLEY AND VIBRATION DAMPENER, AND ENGINE FRONT SUPPORT

### 14-60. General.

a. The crankshaft pulley, mounted on the front end of the crankshaft, is used to transfer drive power from the crankshaft to belt driven accessories such as the water pump, fan and alternator.

b. Vibration dampening is accomplished by bonding a neoprene compound between the crankshaft pulley and the crankshaft hub.

c. The engine front support is the trunnion type, and mounts to the skid base.

### 14-61. Removal and Cleaning.

a. Removal.

(1) Remove crankshaft pulley retaining capscrew and washer. See figure 14-28.

(2) To remove crankshaft pulley, use universal puller kit with threaded adapters that fit into tapped holes on face of pulley.

CAUTION

Do not use gear puller that applies pressure to pulley outer diameter. To do so will result in damage to the pulley.

(3) Remove pulley and dampener assembly, and the woodruff key from the crankshaft.

(4) Remove the two screws in the engine front support assembly that secure the bracket set. Remove the liners. See figure 14-29.

(5) Note the number of shimming washers removed between the upper and lower bracket.

b. Cleaning.

(1) Clean pulley and support with cloth or brush dipped in cleaning solvent, Federal Specification P-D-680.

(2) Ensure that neoprene dampener is not exposed to cleaning solvent.

### 14-62. Engine Front Support Inspection.

Inspect front support for cracking or other signs of damage.

### 14-63. Crankshaft Pulley and Vibration Dampener and Engine Front Support Installation.

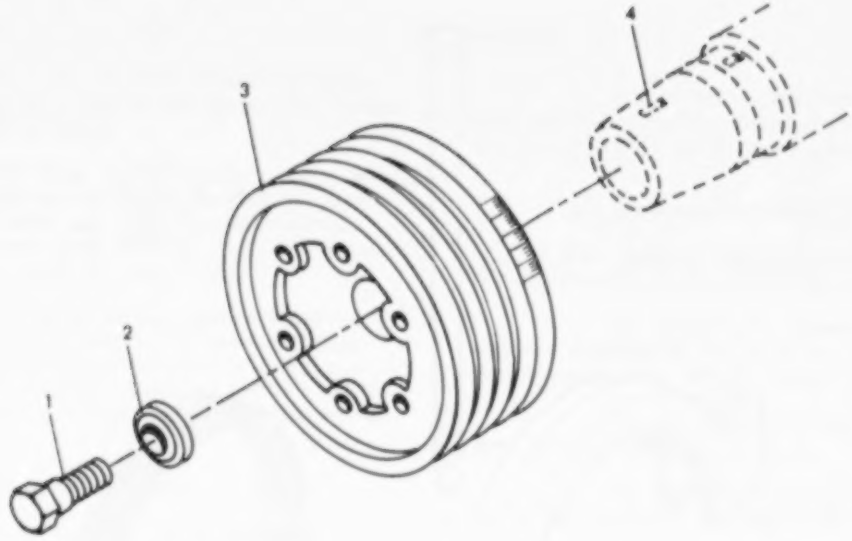
a. Remove any burrs from crankshaft with a fine mill file, if necessary, and install woodruff key into crankshaft keyway.

b. Align crankshaft pulley and dampener assembly keyway with the crankshaft keyway and install assembly on crankshaft.

c. Install retaining capscrew and washer and tighten capscrew to 200 to 220 foot-pounds.

d. Insert liners in front support brackets.

e. Install bracket on cross-member in position on main frame. Install bracket securing hardware.



1. Screw
2. Washer
3. Pulley
4. Key

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Figure 14-28. Crankshaft Pulley and Related Parts

NOTE

Do not tighten at this time.

f. Lower engine into position on bracket and install exact number of washers as noted during removal and install bracket cap and securing capscrews.

g. Tighten bracket cap securing capscrews evenly to a torque of 95 to 105 foot-pounds. Determine the amount of shimming washers necessary to fill the gap between ends of the bracket and cap.

NOTE

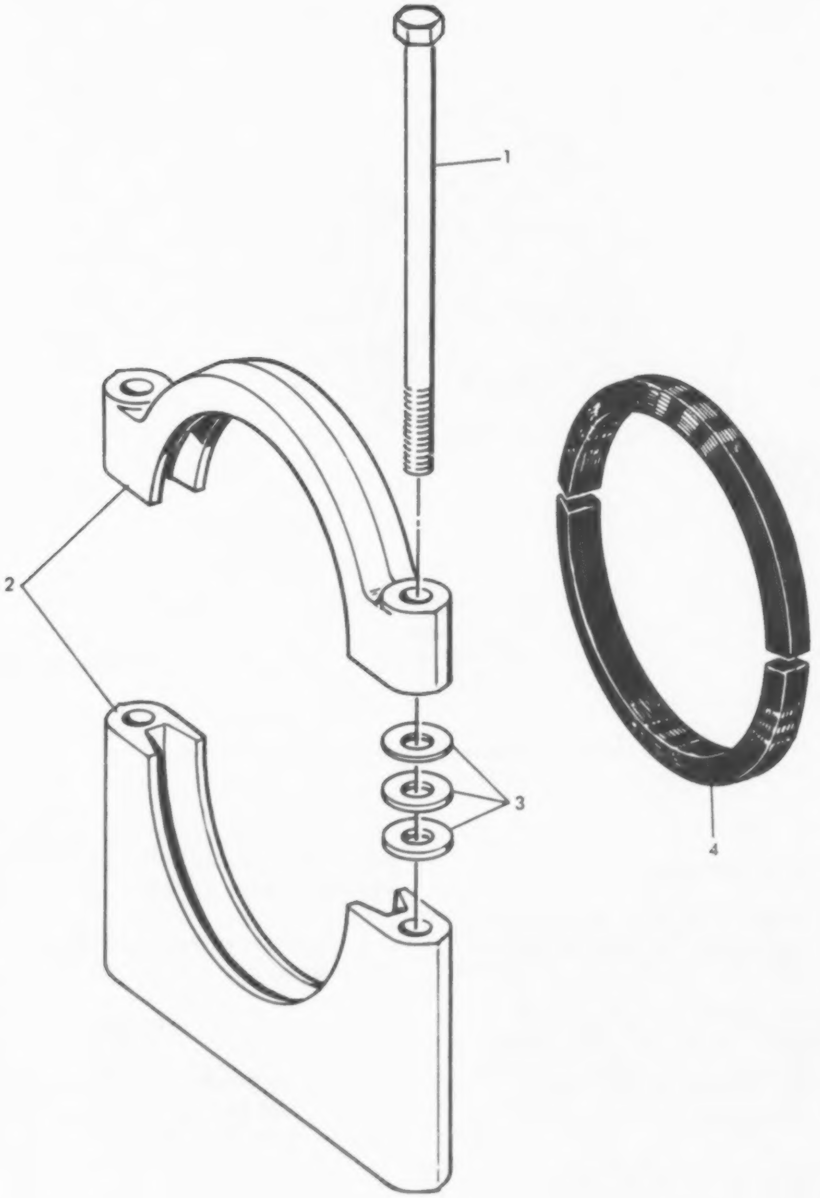
Shimming washers are 1/32 inch thick and must be evenly distributed on both sides of bracket.

h. If original washers do not satisfy this requirement, remove capscrews and install shimming washers to equal the gap.

i. Install capscrews and torque to 95 to 105 foot-pounds.

CAUTION

The bracket assembly must be a tight fit on trunnion to avoid movement of liners.



1. Screw
2. Bracket set
3. Washer
4. Liner

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Figure 14-29. Engine Front Support

## Section XII. OIL PUMP AND OIL PAN ASSEMBLY

### 14-64. General.

a. The gear-type oil pump is mounted on the front of the cylinder block and the drive gear meshes with the crankshaft gear.

b. A relief valve, located in the oil pump outlet, bypasses oil back to the oil pan when the pressure exceeds 82 to 98 psi. This relieves excessive discharge pressure when starting a cold engine and cuts down wear on the oil pump gears.

c. The oil pan serves as a bottom cover for the crankshaft and a reservoir for the lubricating oil. A finned steel tube is installed in the oil pan. Heated coolant is circulated through the tube to preheat the oil to aid in engine starting in sub-freezing temperatures.

### 14-65. Removal and Disassembly.

a. Symptoms and Isolation of Malfunction. A malfunction of the oil pump or a leak in the oil pump is usually indicated by loss of oil pressure which results in engine shutdown. To isolate the malfunction, proceed as follows:

(1) Examine the oil pan for evidence of leakage. Leaking oil can be detected on top of the fuel tank located directly below the oil pan.

(2) Check the oil level. If the level is sufficient for normal operation, and engine has shut-down due to loss of oil pressure, the malfunction is probably the result of oil pump failure. Isolate oil pump failure as follows:

(a) Remove valve cover. Refer to TM 5-6115-545-12 and start engine. Before releasing start switch move the battle short switch to the ON position to by-pass the low oil pressure cut-out switch.

(b) If there is sufficient pressure from the oil pump, oil should be forced out of the rocker arm shaft above each cylinder. If there is no evidence of oil flow at these points, the oil pump has failed. Stop the engine and proceed with the removal and repair procedures.

b. Removal and Disassembly.

(1) Drain fuel system and remove main fuel tank.

(2) Remove electric starter, tool box and fuel-burning heater if installed. Refer to Operator and Organizational Maintenance Manual.

(3) Open oil pan drain valve and allow oil to drain.

(4) Close valves for coolant inlet and outlet to the engine block if a winterization kit is installed.

(5) Disconnect coolant inlet and outlet lines to oil pan heater element if winterization kit is installed. Refer to TM 5-6115-545-12 for winterization kit.

(6) Disconnect oil drain hose.

(7) Refer to figure 14-30 and remove and disassemble the oil pan and heater as follows:

(a) Remove 32 capscrews and lockwashers securing the oil pan to the flywheel housing, timing gear cover, and the clyinder block.

(b) Jar the oil pan loose, drop the rear end, and remove pan.

(c) Remove the brass fittings from the inside and outside of the connections on the oil pan.

(d) Remove the nuts, lockwashers, and capscrews securing the heater element clamps to the inside of the oil pan. Remove the heater element

(8) See figures 14-31 and 14-32 and remove and disassemble the oil pump as follows:

(a) Remove the clamp supporting the oil suction tube.

(b) Uncouple the brass compression fitting securing the oil pump discharge tube.

(c) Remove the bolts securing the oil pump to the cylinder block and remove the oil pump assembly. The pump may have to be pried off its mounting dowels.

(d) Remove the oil pump suction tube support bracket from the main bearing cap.

(e) Wash the oil pump assembly in cleaning solvent, Federal Specification P-D-680.

(f) Remove the suction tube assembly.

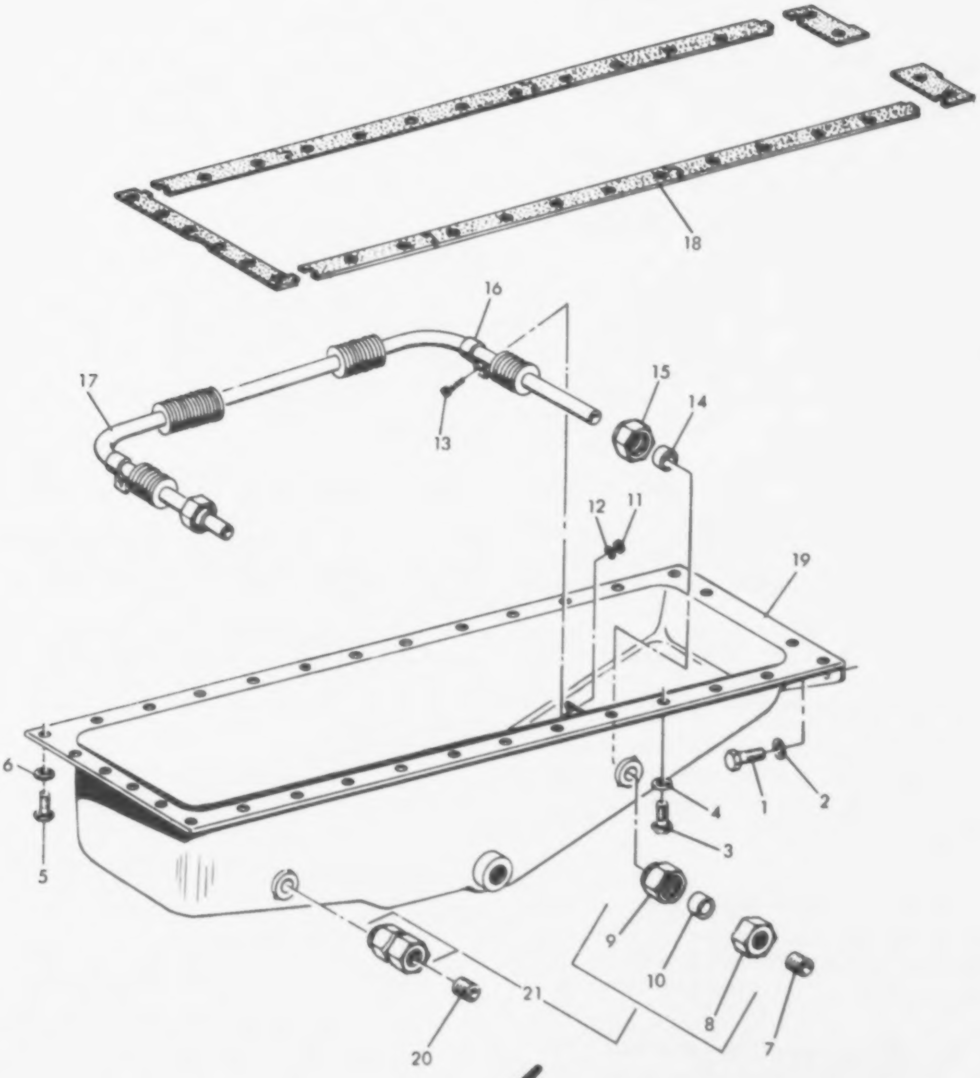
(g) Remove the pressure relief valve assembly from the pump body.

(h) Depress the relief valve spring and retainer with two screwdrivers or on improvised two-prong tool. Drive out the roll pin and remove retainer, spring and relief valve piston.

(i) Remove the oil pump drive gear from the drive shaft. Use a three-leg puller to avoid damage to the gear.

(j) Remove the screws and washers securing the pump cover to the body assembly and remove the pump cover.

(k) Remove the pump driver gear and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1. Screw
2. Washer
3. Screw
4. Washer
5. Screw
6. Washer
7. Plug
8. Adapter
9. Nut
10. Bushing
11. Nut
12. Washer
13. Screw
14. Bushing
15. Nut
16. Clamp
17. Heater
18. Gasket
19. Oil pan
20. Plug
21. Connector assembly

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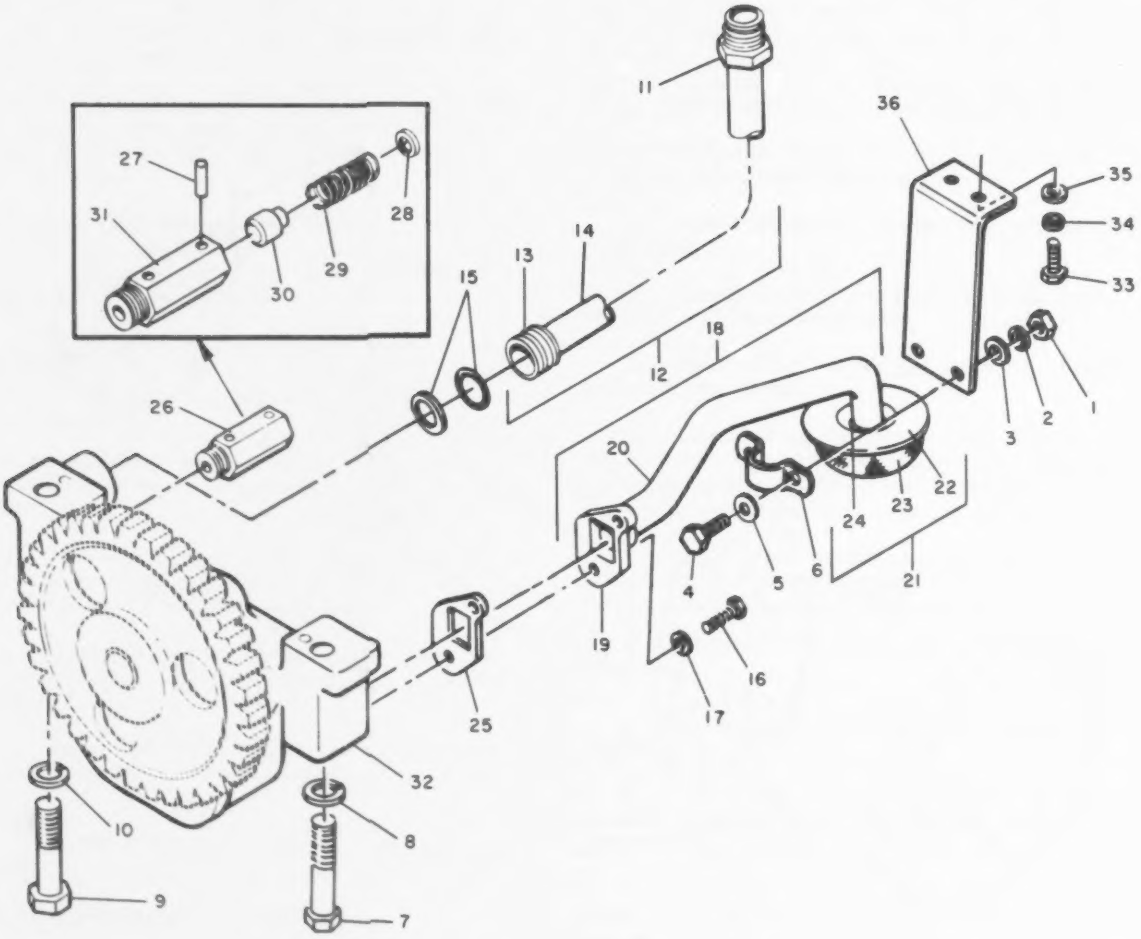
Figure 14-30. Oil Pan and Heater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1. Nut
2. Washer
3. Washer
4. Screw
5. Washer
6. Clamp
7. Screw
8. Washer
9. Screw
10. Washer
11. Nut
12. Tube assy
13. Adapter
14. Tube
15. Preformed packing
16. Screw
17. Washer
18. Tube assy
19. Flange
20. Tube
21. Screen assy
22. Retainer
23. Screen
24. Ring
25. Gasket
26. Valve assy, relief
27. Pin
28. Washer
29. Spring
30. Piston
31. Body
32. Oil pump
33. Screw
34. Washer
35. Washer
36. Bracket

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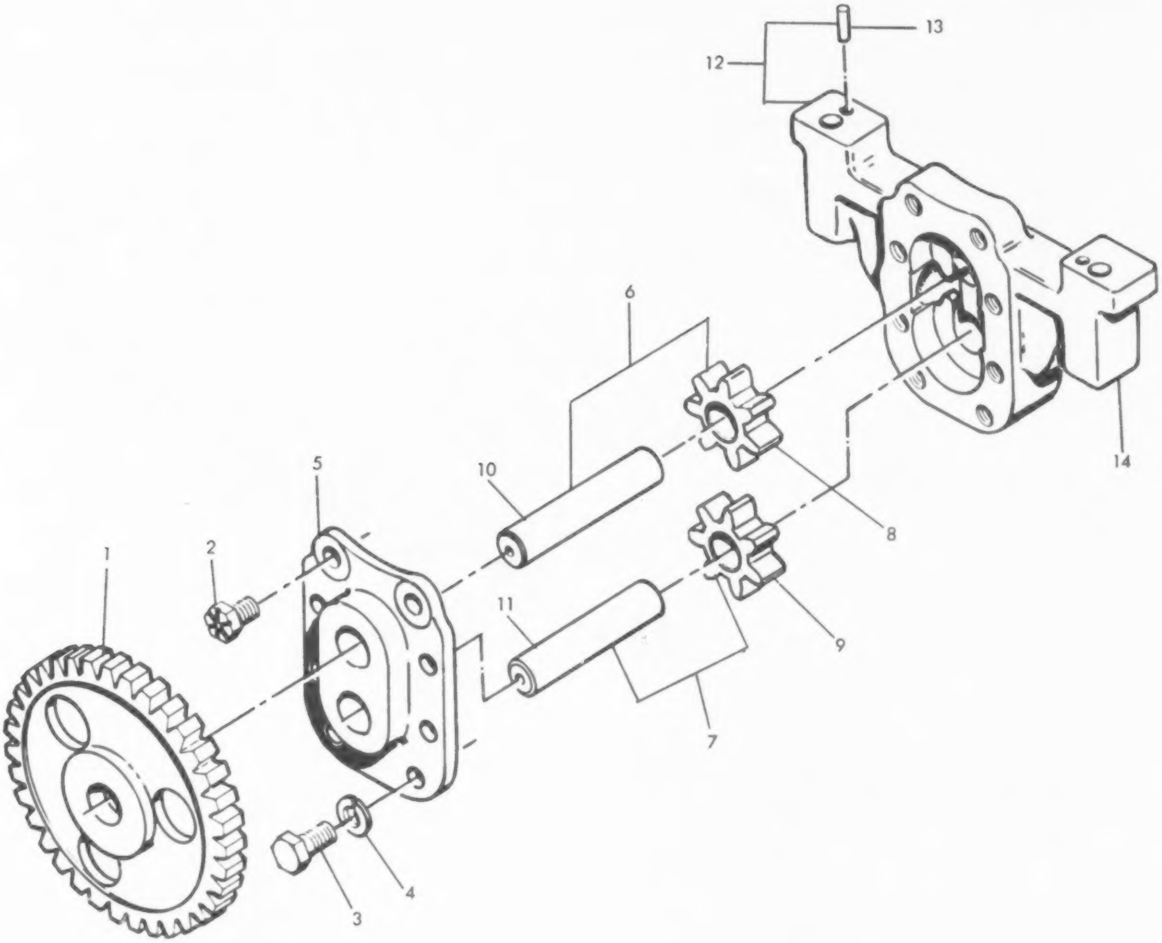
Figure 14-31. Oil Pump and Related Parts



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| | |
|---|---|
| 1. Gear | 8. Gear |
| 2. Bolt | 9. Gear |
| 3. Bolt | 10. Shaft |
| 4. Washer | 11. Shaft |
| 5. Cover | 12. Body assy |
| 6. Gear shaft assy | 13. Pin |
| 7. Gear shaft assy | 14. Body |

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Figure 14-32. Oil Pump Assembly

shaft assembly from the pump body.

(l) Remove the pump driven gear and shaft assembly from the pump body.

(m) To prevent damage to the drive gear teeth and driven gear teeth do not remove the gears from the shaft with a gear puller. Press the gears from the shafts.

## 14-66. Cleaning, Inspection and Repair.

a. Wash all pump parts in cleaning solvent, Federal Specification P-D-680.

b. Inspect the oil pump drive gear, the driver gear and shaft assembly and the driven gear and shaft assembly for wear and chipped teeth. Replace worn and damaged parts.

c. Inspect the inside of the pump body and the inner face of the cover for wear or scoring. Replace damaged part.

d. Inspect the relief valve piston. It must slide smoothly in the bore of the relief valve body. Replace a damaged relief valve or body.

e. Inspect the heater element for cracks, and loose or bent fins. Replace element, if it is severely damaged.

f. Inspect oil pan for dents or cracks. Dents must be smoothed out. Replace oil pan if badly damaged.

g. Inspect suction tube assembly for holes and deformity.

## 14-67. Reassembly and Installation.

a. Heat the driven oil gear in oil to 350° + 25° and press onto the shaft 0.848 inch from end.

b. Repeat step a. for the driver oil gear, except that the gear is pressed onto the shaft 1.812 inches from the end.

c. Lubricate gear and shaft. Install the long end of the driven gear and shaft assembly into the lower chamber of the oil pump body.

d. Lubricate gear and shaft. Install the short end of the driver oil gear and shaft assembly into the upper chamber of the oil pump body.

e. Assemble the pump cover onto the pump body. Use the two 5/8-inch long, grade 5, lock bolts in the top holes. The six other holes use 1-inch bolts with a lockwasher. Tighten the bolts to a torque of 18 to 20 foot-pounds.

f. Before proceeding make certain that the assembled pump will turn freely without binding.

g. Heat the oil gear shaft and press the drive gear onto the shaft allowing 0.057 to 0.062 inch to protrude.

h. Install the piston, spring, and spring retainer in the relief valve body. Depress relief valve spring and retainer with two screwdrivers or an improvised two-prong tool. Insert a 3/16-inch, or less, drift pin into the roll pin hole. Hold the retainer with the drift pin until the roll pin is installed.

i. Install the relief valve assembly into the pump body and tighten securely.

j. Install the suction screen assembly onto the pump body.

k. Install heater element in the oil pan and secure it with nuts, lockwashers and capscrews.

l. Install the brass fittings on the inside and outside of the oil pan.

m. Lubricate oil pump drive gear and install oil pump assembly onto the cylinder block with the drive gear in mesh with the crankshaft gear. Install bolts and torque to 68 to 73 foot-pounds.

n. Position brass fittings and O rings and install oil discharge tube to cylinder block and oil pump assembly; tighten fitting securely.

o. Install support bracket and clamp securing oil suction line.

p. Install a new gasket set to the rails of the oil pan.

q. For ease of installing the oil pan, make up two guide studs and screw them into the diagonal corners of the cylinder block.

r. Position the oil pan with the front end up and mount the oil pan on the guide studs. Hold it in position by inserting a capscrew and lockwasher in each corner, but do not tighten them so that the oil pan can be shifted.

s. Remove the guide studs. Install the 3/4-inch long capscrews and lockwashers which hold the rear flange of the oil pan to the flywheel housing. Tighten the rear corner capscrews in the side rail and the two upper capscrews in the flywheel housing alternately, until secure.

t. Install the 1-inch long capscrews and lockwashers, securing the front rail of the oil pan to the timing gear cover. Install the remaining capscrews and lockwashers. Tighten all capscrews securely to a torque of 28 to 33 foot-pounds.

u. Install drain valve into oil pan and tighten securely.

v. Install oil drain hose, and connect coolant lines to the heater element if winterization kit is installed.

w. Open valves for coolant in and out of the heater element if winterization kit is installed.

x. Install electric starter, tool box and fuel burning heater if used.

y. Install main fuel lines, then fill and check for leaks.

z. Fill the oil pan to the proper level with the specified engine crankcase lubricant. Run engine and check for oil leaks.

## Section XIII. FLYWHEEL AND HOUSING

### 14-68. General.

The flywheel is mounted on the rear of the cylinder block. Its purpose is to insure a smooth flow of torque at the engine drive output. The rotor of the main generator is attached with two disk type steel couplings to the flywheel.

### 14-69. Removal, Inspection and Repair.

a. Symptoms and Isolation of Malfunction. A malfunction associated with the flywheel is usually indicated by excessive vibration and noise.

b. Removal.

(1) Remove engine from unit (para 2-13). Support engine on blocks or suitable stand.

(2) Remove electric starter. Refer to Operator and Organizational Maintenance Manual.

(3) Remove six hexsocket capscrews attaching flywheel to crankshaft flange. See figure 14-33.

(4) Install two long capscrews in opposite holes of the flywheel face to serve as handles. Pull on capscrew handles while supporting flywheel weight and remove flywheel.

NOTE

If flywheel cannot be removed with a direct pull on the handles, it may be necessary to tap flywheel with a suitable brass bar through the electric starter mounting opening. Turn flywheel and tap exposed part at intervals until flywheel can be removed.

(5) Remove ring gear from flywheel by grinding a notch through the ring gear at the root of one of the teeth. Expand the ring and drive it from its position.

CAUTION

Do not attempt to remove ring gear without first expanding it.

(6) The wear sleeve is held in position on the flywheel by a press fit. It is removed with a pry bar or three-jawed external puller. Wear sleeve should be removed with an even motion.

(7) Remove capscrews securing oil pan to flywheel housing.

(8) Remove eight capscrews securing flywheel housing to the cylinder block. Tap the housing with a soft-headed hammer to break it loose from the housing dowels. Remove the housing.

c. Inspection.

(1) Thoroughly clean flywheel housing with cleaning solvent, Federal Specification P-D-680. Remove preformed packing from housing. (See fig. 14-33)

(2) Inspect housing for cracks and other damage.

(3) Inspect ring gear for nicks, cracks, or excessive wear.

(4) Inspect flywheel for nicks, burrs or dents. All burrs, nicks and dents must be removed from the flywheel surface that fits against the crankshaft flange.

### 14-70. Reassembly and Installation.

a. Place flywheel housing on a bench with the preformed packing side up. Drive out the packing from the housing with an oil seal remover.

b. Clean oil seal bore in the flywheel housing.

c. The outer diameter of the seal comes with a layer of red-colored sealant which eliminates the use of a sealing compound on the outer diameter of the seal prior to pressing it into the flywheel housing.

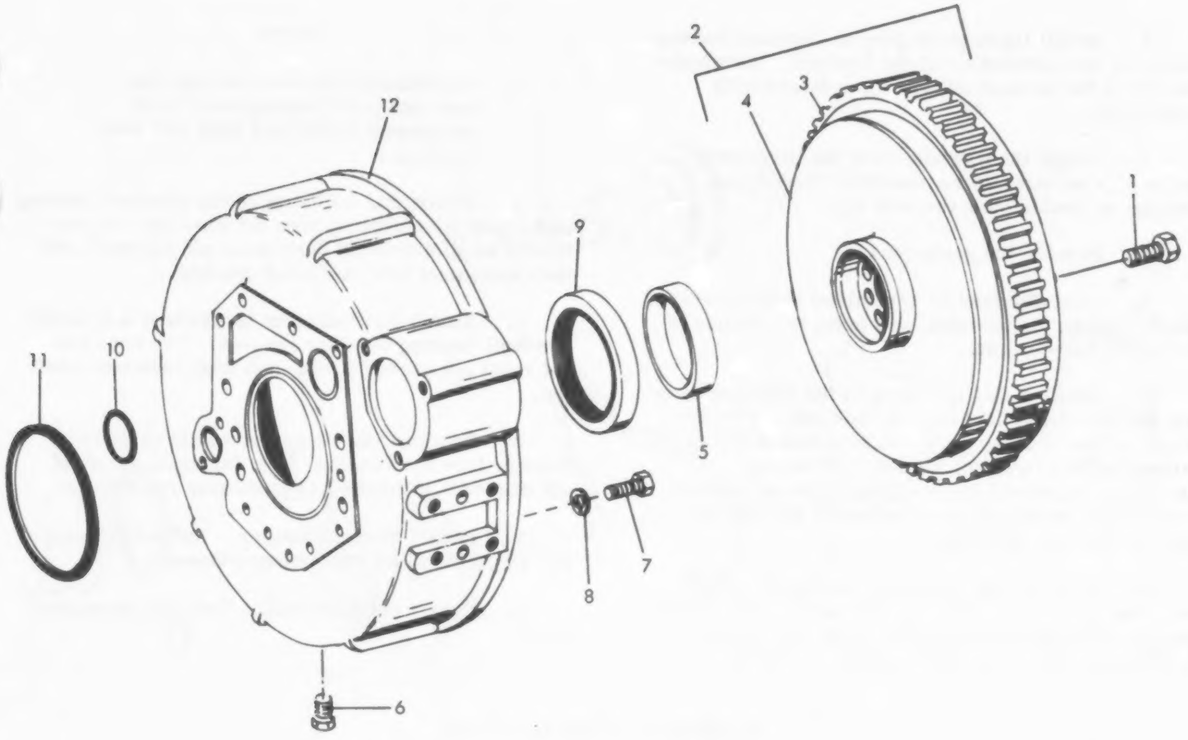
d. Position seal squarely with bore in housing and, using a seal installer, carefully drive seal into flywheel housing until it is seated against the seal stop in the bore.

NOTE

The seal must be installed with open side of seal directed toward the cylinder block.

e. Make certain the crankshaft flange on which the seal rides is free from nicks or burrs. Polish with crocus cloth if necessary.

f. Lubricate flange and sealing lip with clean engine oil. Do not use grease, soap, white lead, etc.



1. Screw
2. Flywheel assy
3. Ring gear
4. Flywheel
5. Wear sleeve
6. Plug
7. Screw
8. Washer
9. Oil seal
10. Preformed packing
11. Preformed packing
12. Housing

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Figure 14-33. Flywheel and Housing

NOTE

Final installation of the flywheel into the seal is blind, therefore, extreme care must be exercised to prevent crimping or cutting the sealing lip of the seal when installing the flywheel.

g. Install flywheel housing on cylinder block and tighten securing capscrews to a torque of 73 foot-pounds. Install oil pan capscrews to flywheel housing and tighten them to a torque of 28 to 33 foot-pounds.

h. Press new wear sleeve onto flywheel flange. Do not use lubricant or sealer. Metal-to-metal contact is necessary for proper heat transfer. Press seal on until its shoulder makes contact with the flywheel.

NOTE

Start ring gear on the flywheel so that when the flywheel is installed, the chamfered ends of the teeth will face the cylinder block.

i. Install the ring gear onto the flywheel by uniformly heating the gear to 300° F (dull red heat visible in the dark). Then, press ring gear onto the flywheel which is at room temperature.

NOTE

Do not overheat the ring gear to a bright red. This will destroy the temper of the gear.

j. Drive gear down tight against the shoulder of the flywheel. Allow the ring gear to cool slowly; do not cool with water.

k. Install three guide pins on flywheel housing to aid in the installation of the flywheel. Lubricate the lip of the oil seal and the wear sleeve with engine oil.

l. Install the flywheel over the temporary guide pins as straight as possible. Do not cut, crimp, or double back the seal lip.

m. Remove the guide pins.

n. After flywheel is assembled to the crankshaft, tighten the flywheel lock bolts to a torque of 95 to 105 foot-pounds.

o. Attach a dial indicator to the flywheel housing and check flywheel face for run-out. Pry flywheel to the rear, to eliminate crankshaft end ply, otherwise dial indicator reading will not be accurate. Flywheel face run-out must not exceed 0.0005 inch maximum total indicator reading per inch of flywheel diameter.

p. Readjust dial indicator so that the stem will ride on flywheel driving ring bore. The eccentricity of the driving ring bore must not exceed 0.0005 inch maximum total indicator reading.

NOTE

> Eccentricity between driving ring bore and pilot bearing bore must not exceed 0.008 inch total indicator reading.

q. Attach dial indicator to the flywheel housing and check pilot bearing bore for run-out. Eccentricity of pilot bearing bore must not exceed 0.005 inch maximum total indicator reading.

r. Attach dial indicator to flywheel and check flywheel housing bore for run-out. The bore run-out must not exceed 0.008 inch total indicator reading.

s. Readjust dial indicator to check flywheel housing face for run-out. The face run-out must not exceed 0.008 inch total indicator reading.

t. Install electric starter. Refer to Operator and Organizational Maintenance Manual.

u. Install engine in unit. Refer to paragraph 2-14.

## Section XIV. TIMING SYSTEM

### 14-71. Description.

a. Timing is preformed by a train of mechanically synchronized timing gears located at the front of the engine. This train consists specifically of four gears: fuel pump drive gear, idler gear, camshaft gear and crankshaft gear. (Class 1 sets contain an additional gear to drive the hydraulic pump).

b. The crankshaft drive gear is the central element of this gear train, driving the other gears either directly or indirectly. The fuel pump drive gear and camshaft gears are timed to the crankshaft gear to provide timed synchronization of fuel injection and valve positions. The idler gear transfers drive power from the crankshaft gear to the fuel pump drive gear.

c. The timing gear cover encloses the gear train and the front end of the engine. The gears are lubricated by the oil splash method.

d. A malfunction in the timing system is usually indicated by an extremely loud knocking sound from the engine or abnormally quiet but sluggish operation of the engine. These symptoms are an indication that the engine is not properly timed. If the engine was operating normally prior to the occurrence of these symptoms, it is an indication that the gear is badly worn or has lost a gear tooth.

### 14-72. Gears and Cover Removal.

a. Timing Gear Cover Removal. See figure 14-34 and proceed as follows:

(1) Remove engine support (para 2-13).

(2) Remove crankshaft pulley and vibration dampener assembly (para 14-61).

(3) Remove oil pan (para 14-65).

(4) Remove inspection plate, capscrews, lockwashers and fuel pump drive gear inspection plate. Remove thrust button with spring from fuel pump drive shaft.

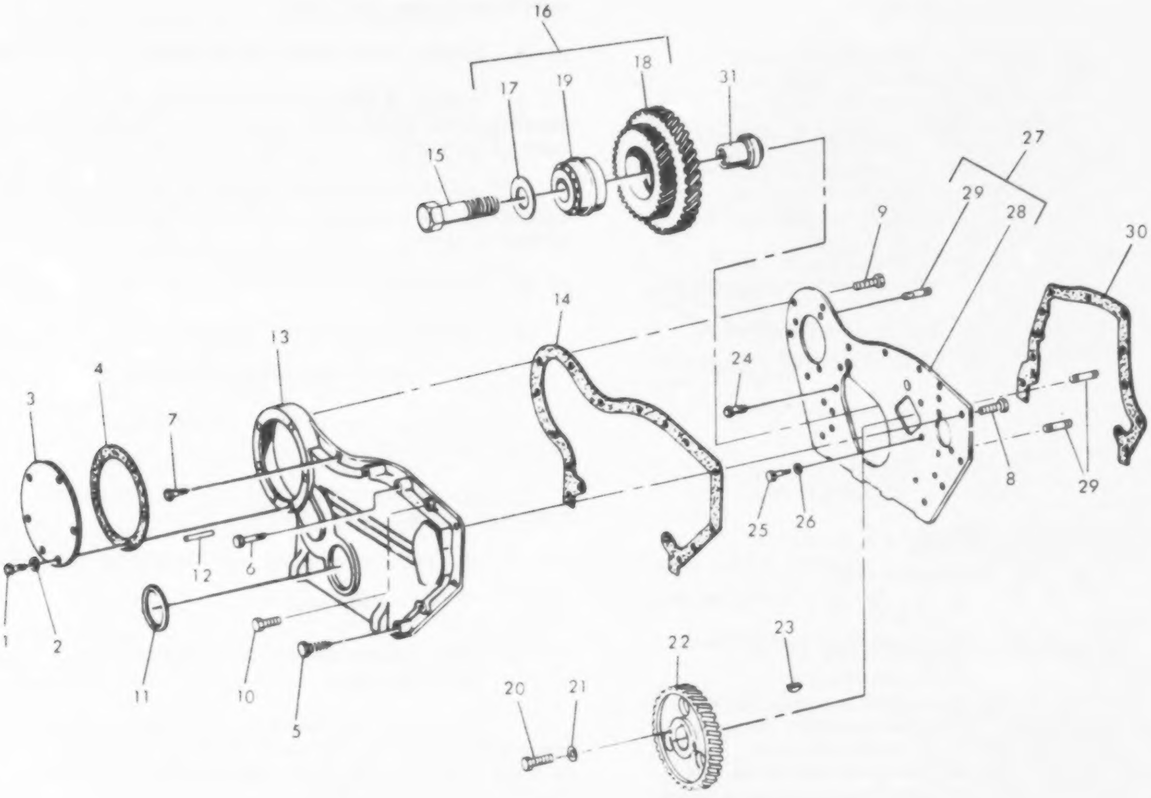
NOTE

> If only the fuel pump drive gear has to be removed and/or replaced, the gear can be removed through the opening in the timing gear cover.

(5) Remove capscrews on front and back side, which secure timing gear cover to cylinder block and engine front plate. Jar cover loose with a soft-headed hammer. Pry cover from locating dowels, and remove it from fencing.

b. Fuel Pump Drive Gear Removal. Refer to note above and figure 14-25 and proceed as follows:

(1) Rotate engine until No. 1 piston is at top dead center on its compression stroke.



1. Screw
2. Washer
3. Cover
4. Gasket
5. Screw
6. Screw
7. Screw
8. Screw
9. Screw
10. Screw
11. Oil seal
12. Pointer
13. Cover
14. Gasket
15. Screw
16. Gear assy
17. Washer
18. Gear cluster
19. Bearing
20. Screw
21. Washer
22. Cam shaft gear
23. Key
24. Bolt
25. Screw
26. Washer
27. Plate assy
28. Plate
29. Stud
30. Gasket
31. Shaft

Figure 14-34. Timing Gear and Cover ME 6115-545-34/14-34 C6

(2) Remove nut and lockwasher securing gear to fuel pump drive shaft.

(3) Remove the fuel injection pump, from the fuel pump drive shaft (para 14-43).

(4) Remove the two oil seals from the fuel pump drive shaft. Inspect oil seals for wear or damage. Replace if necessary.

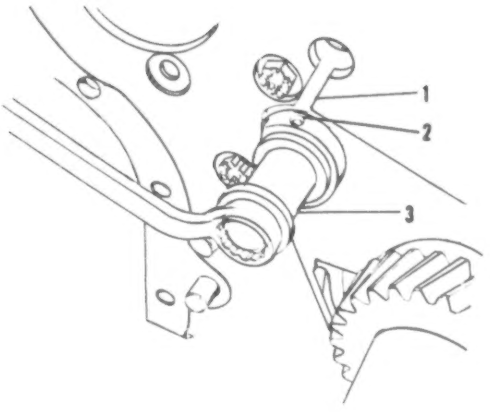
(5) Withdraw the fuel pump drive shaft, with the drive gear attached, from the mounting adapter and through the opening in the timing gear cover.

(6) Position fuel pump drive shaft and drive gear on a press and remove the fuel pump drive gear from the drive shaft. Inspect drive gear and replace if necessary.

c. Idler Gear Removal. See figures 14-34 and 14-35 and proceed as follows:

(1) Remove capscrews and washer securing idler gear. (fig. 14-34)

(2) Remove idler gear with bearings.



1. Slot
2. Oil hole
3. Idler gear shaft

ME 6115-545-34/14-35

Figure 14-35. Idler Gear Shaft Installation

(3) If idler gear shaft is scored or worn it must be replaced. The specified outer diameter on both ends of the idler gear shaft is 0.999" - 1.000". Install a 9/16" - 18 adapter in the end of the idler gear shaft. Install the end of the slide hammer into the adapter and remove the idler gear shaft from the cylinder block.

d. Camshaft Gear Removal. Refer to paragraph 14-77 for removal procedures.

e. Crankshaft Gear Removal. Use bar type puller and remove crankshaft gear.

f. Hydraulic Gear Removal. (Class 1 sets only) (para 14-14)

14-73. Timing Gears and Housing Cleaning and Inspection.

a. Clean cover and gears using cleaning solvent, Federal Specification P-D-680.

b. Clean all gasket material from timing gear cover using care to prevent scoring or gouging of surface.

c. Inspect front support plate for damage and wear.

d. Inspect idler gear shaft for scoring or wear. The center diameter on both ends must be 0.999 to 1.000 inch.

e. Inspect all gears for excessive wear and chipped or broken gear teeth.

14-74. Timing Gears and Housing Repair.

a. Repair is limited to replacement of housing, front support plate, or gears if badly worn or damaged.

b. Replace idler gear shaft if scored or excessively worn beyond the allowable limits. Refer to step d. above.

14-75. Installation.

a. Crankshaft Gear Installation.

(1) Install woodruff key in crankshaft.

(2) Heat gear in oil to a temperature of approximately 300° F.

(3) Coat crankshaft at gear location with a mixture of white lead and oil.

(4) Drive or press gear onto crankshaft.

CAUTION

Use asbestos gloves when handling the heated gear.

(5) When crankshaft is installed in engine make certain that timing mark on crankshaft gear is aligned with timing mark, on camshaft gear when crankshaft gear is installed.

b. Camshaft Gear Installation. See figure 14-35 and proceed as follows:

(1) Insert idler gear shaft into cylinder. Block bore so that oil hole on top of shaft aligns with slot in front plate.

(2) Insert washer and capscrew into idler gear shaft (see fig. 14-34) and tighten capscrew until shaft bottoms in cylinder block.

NOTE

The bore size of the roller bearing is 1.000 - 1.008 inches and the outer diameter of the outer race of the bearing is 1.980 - 1.981 inches. The bore size of the idler gear is 1.9785 - 1.9795 inches and the bore size of the groove in the idler gear for the spacer is 2.068 - 2.078 inches. If the bearing assembly is worn, drive the outer races out with a punch and press in the new races until they contact the newly installed spacer.

(3) Position idler gear bearings with spacer between them in idler gear.

(4) Apply a light coat of engine oil to idler gear shaft. Position idler gear with bearings on idler shaft making certain the timing marks on the idler gear and the crankshaft gear are lined up properly when number 1 piston is at top dead center, as illustrated in figure 14-25.

(5) Install capscrew with washer and tighten capscrew to a torque of 95 to 105 foot-pounds.

NOTE

The allowable end play of the idler gear bearing is a minimum of 0.001 inch.

c. Fuel Pump Drive Gear Installation.

(1) Coat fuel pump drive shaft with engine oil and install shaft in pump mounting adapter. Install woodruff key.

(2) Position drive gear on drive shaft with the keyway lined up with the woodruff key. Install lockwasher and nut on drive shaft and tighten nut to a torque of 35 to 40 foot-pounds.

NOTE

During the assembly of the engine or replacement of any of the timing gears it is necessary to align the timing marks as shown in (fig. 14-25, view B). After aligning the marks, rotate the flywheel counter-clockwise (view from timing gear end) until the proper degree timing mark (for the specified rpm) on the pulley and damper assembly is registered with the pointer on the front of the timing gear cover. The engine is now properly positioned for the installation of the fuel pump.

NOTE

Check backlash between all gears. Backlash between any two mating gears must not exceed 0.015 inch. New parts must be installed if backlash exceeds this requirement. Refer to para 14-74 for replacement of gears.

d. Oil Seal.

(1) Clean the timing cover bore to receive a new seal.

NOTE

The outer diameter of the front oil seal has a layer of red-colored sealant which forms a seal between the outer diameter of the seal and the bore in the cover. The bore of the seal has a layer of rubber compound to prevent oil leakage between the seal and the crankshaft.

(2) Place timing cover on a flat surface with the front side to the top.

(3) Position seal in timing cover with open side of seal facing down and positioned squarely in bore of cover.

CAUTION

Make certain that seal is not cocked in timing cover bore.

(4) Drive or press seal into timing cover bore until it bottoms.

CAUTION

Do not press on open face of seal or damage will occur.

(5) After seal is installed in the cover, insert fingers into inner part of seal and check for rotation. If seal was installed properly, the inner part will turn with a firm feel to the fingers.

e. Cover Installation.

(1) Inspect and remove burrs from keyway in crankshaft, using a fine-cut mill file or stone, to prevent damaging the inner layer of rubber of the crankshaft oil seal.

(2) Coat crankshaft lightly with engine lubricating oil.

(3) Cement (permatex or equivalent) a new gasket to the timing gear cover.

(4) Using a direct reversal of the removal procedure, position the gear cover on the two dowel pins in the cylinder block and complete the installation of the cover and the component parts. Tighten all capscrews, securing the cover to a torque of 28-33 foot-pounds. Also tighten the six capscrews securing oil pan to timing gear cover to a torque of 28-33 foot-pounds.

f. Crankshaft Pulley Installation. Install crankshaft pulley and vibration dampener assembly. (para 14-63)

## Section XV. CYLINDER HEAD AND VALVE OPERATING MECHANISM

### 14-76. General.

a. The cylinder head is a one-piece alloy iron casting and is secured to the upper part of the cylinder block by heat-treated capscrews. Inlet and outlet ports are provided in the cylinder head for the intake of air and the expulsion of exhaust gases. Cored passages are provided for the circulation of coolant. Located in the cylinder head above each cylinder is an intake valve, valve guide, valve spring, spring retainer and locks, an exhaust valve, valve guide, valve spring, spring retainer and locks, a fuel injection nozzle, and two rocker arms. The top of the cylinder head is enclosed with a cylinder head cover and sealed with a gasket.

b. The rocker arm assembly, consisting of two rocker arms for each cylinder, is mounted on a common rocker arm shaft supported by rocker arm shaft brackets attached to the cylinder head. One rocker arm actuates the intake valve and the other actuates the exhaust valve.

c. The camshaft rotates in bearings mounted inside the cylinder block. It is mechanically timed with the crankshaft to open and close valves at proper intervals. Valves are operated by camming action produced by lobes located along the length of the camshaft.

d. The push rods extend down through the cylinder head, cylinder block, and into valve lifters which are held in position by the camshaft. The upper end of the push rods are concave to receive the ends of the valve lash adjustment screws threaded into one end of the rocker arms. The other end of the rocker arm actuates the valve through the action of the push rod. When the push rod is forced upward by the camshaft lobe, the rocker arm is raised on one end and forced down on the other end, opening the valve. The tension of the valve spring closes the valve when the push rod moves downward.

e. An oil hole through the cylinder head at the flywheel end extends from the engine oil gallery. An oil feed tube is connected from the cylinder head to a restrictor elbow in one end of the hollow rocker shaft. Excess oil is dumped through an oil drain tube at the other end of the rocket shaft. The oil feed tube and drain tube are formed higher than the rocker shaft to help force oil out the holes in the rocker shaft through the oil hole in the rockers, and keeps the shaft full of oil during engine shutdown. The restrictor elbow controls oil flow to the rockers and prevents excessive pressure drop of the engine oil pressure system. Oil is forced out of the shaft through the oil hole at each rocker arm location and into the drilled passage of each rocker arm, providing lubrication for the rocker arm bushing. The oil spills down at the front end over the push rods and valve springs and drains back to the oil pans.

### 14-77. Removal and Disassembly.

a. Symptoms and Isolation of Malfunction. A malfunction of the cylinder head assembly or valve-operating component is usually indicated by loss of engine power, erratic engine speed, or heavy black exhaust smoke. These symptoms are a result of compression losses caused by a leaky head gasket, cracked cylinder head, burned valve, bent, worn, or broken push rod, or a defective rocker arm. To isolate the cause of the malfunction, proceed as follows:

(1) Remove the valve cover and observe the rocker arms with the engine running. If one of the rocker arms or push rods has failed, it can usually be detected by comparing the motion of all the rocker arms.

(2) One by one, slightly loosen the fuel input line to each injector with the engine running. This stops fuel to the cylinder. If the engine speed and sound does not change when the fuel to the cylinder is reduced, a valve in that cylinder has probably failed. Tighten each fuel line after check has been made. To verify a valve failure, remove one at a time the fuel injector for each cylinder and perform compression tests using a 0-700 psi gauge. The compression pressure at sea level with engine at cranking speed, 150 rpm (use dead crank switch) and hot should be 400 ±15 psi.

(3) A leaky head gasket or a crack in the head can usually be determined by visual inspection. Signs of coolant leakage will be evident at the point where the head mates with the block if the gasket is bad. A crack in the cylinder head is usually indicated by the presence of an irregular hairline surrounded by signs of coolant leakage or a black deposit of exhausted carbon.

(4) If any of the above checks indicate failure of a cylinder head component, proceed with the removal and repair procedures.

b. Cylinder Head and Rocker Arm Shaft Assembly Removal.

(1) Refer to Operator and Organizational Maintenance Manual to drain the cooling system, disconnect ether starting aid and remove, the turbocharger, intake and exhaust manifold, nozzle holder assemblies valve cover.

(2) Disconnect oil feed tube compression nut from fitting in cylinder head at flywheel end of rocker arm shaft. See figure 14-36.

(3) Disconnect compression nuts and remove oil drain tube and oil feed tube at corresponding ends of rocker arm shaft.

(4) Remove the six 3/8 inch capscrews and lockwashers securing the rocker arm brackets to the cylinder head. Remove the six long capscrews securing the rocker arm brackets; remove the rocker arms, shaft, and brackets as an assembly.

(5) Withdraw the push rods from the engine.

(6) Remove the remaining twenty capscrews securing the cylinder head and the two engine lifting eyes. Use a sling and remove cylinder head.

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**NOTE**

> Lift cylinder head straight up until it clears the two dowel pins in the block; then move cylinder head to the left to avoid bending the fuel injection lines. Remove the cylinder head gasket.

### c. Rocker Arm Shaft Assembly Disassembly.

(1) Refer to figure 14-37. Remove plug, spring washer, and washer from each end of the rocker arm shaft.

(2) Remove shaft locating capscrew and lockwasher in the top of the rocker arm bracket (third bracket from front end).

**NOTE**

> Replacement brackets will all contain threaded hole in the top of the rocker arm bracket.

(3) Slide rocker arms, springs, and brackets from the rocker arm shaft.

### d. Cylinder Head Assembly Disassembly.

(1) Using a spring compressing tool, remove spring retainer locks, and carefully release tension on the valve spring. Remove spring retainer and valve spring. See figure 14-38.

(2) Place valves in a rack as they are removed from cylinder head so they can be identified and reinstalled in their original locations.

(3) The valve guides may be removed by pressing them out through the top of the cylinder head.

(4) Remove valve seats by electrically welding three small beads on inside circumference of insert as illustrated in figure 14-39. Allow insert to cool, then lift or pry out with a bar.

### e. Camshaft, Camshaft Gear, and Valve Lifter Removal.

(1) Refer to para 14-72 and remove timing gear cover.

(2) Refer to paras 14-18 and 14-21 and remove the overspeed switch, adapter and tachometer drive.

(3) Before removing the camshaft from the cylinder block, check the camshaft gear backlash. The backlash between the mating gears of the crankshaft and the camshaft is 0.0015 to 0.0009 inch. New parts must be installed when the backlash between any two mating gears exceeds 0.015 inch. The backlash between hydraulic pump gear and camshaft is 0.003 to 0.011 inch.

(4) Remove capscrew and washer securing camshaft gear to camshaft. (See fig. 14-35.)

(5) Before the camshaft can be withdrawn from the cylinder block, the valve lifters must be positioned so that they do not interfere with the camshaft lobes.

(6) With the engine removed from the unit for overhaul, simply lay the cylinder block on its side and push the valve lifters to their uppermost position and carefully withdraw the camshaft.

**CAUTION**

> Be careful that the camshaft lobes do not scratch or mar the camshaft bearings as the camshaft is withdrawn from the cylinder block.

(7) If the engine is mounted in a unit, the valve lifters can be held in their uppermost position in the following manner:

(a) Make up twelve pieces approximately 16 inches long of 5/8 inch wooden dowel rod and taper one end of each slightly.

(b) Insert the tapered ends of the dowels into the valve lifters (fig. 14-40) into the holes for the push rods in the cylinder block and force each one into a valve lifter.

(c) Grasp adjacent dowels for a set of exhaust and intake valves carefully pull the exhaust and intake valve lifters up to their uppermost position and place a stout rubber band around the two adjacent dowels. Repeat for each set of valves.

(8) It may be necessary to rotate the crankshaft so that the connecting rods will not interfere with the camshaft lobes during removal.

(9) After removing, the camshaft with gear from the cylinder block, check the thrust plate clearance (end play) by inserting a feeler gauge between the thrust plate and camshaft journal. The end play is 0.0027 to 0.0083 inch. If the end play exceeds the maximum wear limit of 0.015 inch with a new thrust plate, the camshaft gear must be replaced.

(10) The valve lifters may now be removed by removing the dowels.

(11) Place the camshaft in a press and force the camshaft from the gear. This is necessary due to the press fit.

14-78. Cleaning, Inspection and Repair.

a. Cleaning and Inspection of Cylinder Head.

(1) Steam-clean cylinder head.

(2) Clean deposits of salt, lime or sludge from water jacket.

(3) Submerge cylinder head in tank of cleaning solution, Federal Specification P-D-680 heated to near boiling point. Remove and dry thoroughly.

(4) Clean crossheads, valves, and valve springs by submerging in solvent. Remove from solvent tank and dry thoroughly.

(5) Clean valves with buffer and polish with crocus cloth.

(6) Examine cylinder head carefully for cracks.

b. Valve Spring, Valve Guide, Valve Seat and Valve Inspection and Repair.

(1) Inspect valve springs for cracks. Place spring in test stand. Both intake and exhaust valve springs with dampers should have a load of 40-46 pounds when compressed to a length of 2.237 inches (valve closed) and a load of 105-115 pounds when compressed to a length of 1.780 inches (valve open). Install new spring when old spring is 5 percent under or over load limits.

(2) Replace intake and exhaust valves if they are cracked, bent, burned or stems are worn. The outer diameter of exhaust valve stem is 0.3705 to 0.371 inch. Bore of exhaust valve guide is 0.3725 inch giving stem-to-guide clearance of 0.0015 to 0.002 inch. Replace exhaust valve and/or guide if clearance exceeds 0.0055 inch. Outer diameter of intake valve stem is 0.3715 to 0.372 inch. Bore of intake valve guide is 0.3725 inch giving stem-to-guide clearance of 0.0005 to 0.001 inch. Replace intake valve and/or guide if clearance exceeds 0.0035 inch.

(3) Inspect valve seats. Replace if cracked, pitted, or loose. Removal is described in para 14-77.

c. Valve Seat Insert Installation.

NOTE

Press fit of valve seat inserts must be maintained. If insert bores in cylinder head are badly worn, bores must be machined 0.005 inch larger than original' bore. Valve seat inserts 0.005 inch oversize must be installed.

(1) Inspect valve seat counterbores for cleanliness, burrs, and correct size. (1.655 to 1.666 inches for exhaust valve, 1.809 to 1.810 inches for intake valve, 1.670 to 1.671 inches for 0.005 inch oversize exhaust valve end 1.814 to 1.815 inches for 0.005 inch oversize intake valve).

(2) Depth of exhaust valve bore is 0.4735 to 0.4755 inch and 0.4585 to 0.4605 inch for intake valve.

(3) Chill inserts for two to four minutes in a dry ice container or cold box.

(4) Place cylinder head bottom side up on a bench. Thoroughly clean counterbores for the inserts with compressed air and start an insert into the counterbore (valve seat side up).

(5) Use a valve seat insert installing tool and drive insert down tightly into counterbore. This operation must be done quickly while insert is cold.

(6) Exhaust valve seat inserts must be staked to eliminate the possibility of the insert loosening in its bore.

d. Valve Face and Valve Seat Grinding.

NOTE

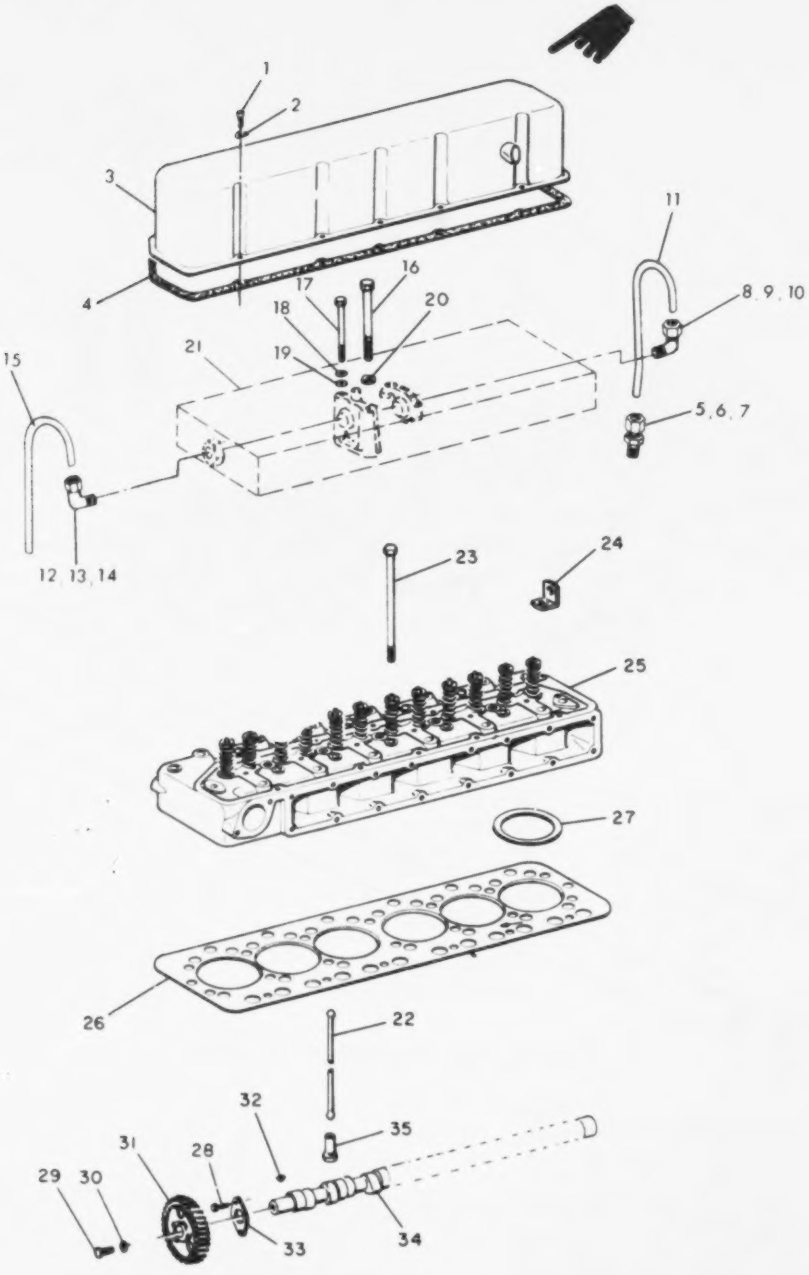
Before installing either new valves or used valves, valve seats in cylinder head should be inspected for proper valve seating. If used valves are to be reinstalled, valve stems should be cleaned and valve faces ground to angles of 30° for exhaust and intake valves. When refacing valves, remove all evidence of pitting and grooving. The valve guide should be cleaned with a nylon brush. If bore in valve guide is worn oblong, or if valve head is warped relative to valve stem, the necessary parts must be replaced. When new valve seat inserts are installed, or used inserts reseated, refinishing must be done with a valve seat grinder.

(1) The cutting face of the stone must be maintained at the correct angle and in proper condition by frequent dressing with a diamond wheel dresser. The frequency of dressing will be determined by condition of the seats and amount of metal required to be removed during the grinding operation.

NOTE

By grinding valve face and insert seat at slightly different angles, a fine line contact of the face and seat is obtained, thus eliminating the need to lap the seating surfaces with grinding compound.

(2) The difference of angles is usually 1/2 to 1-1/2°. The angle of the insert seat is made greater than that of the valve face, so as to assure contact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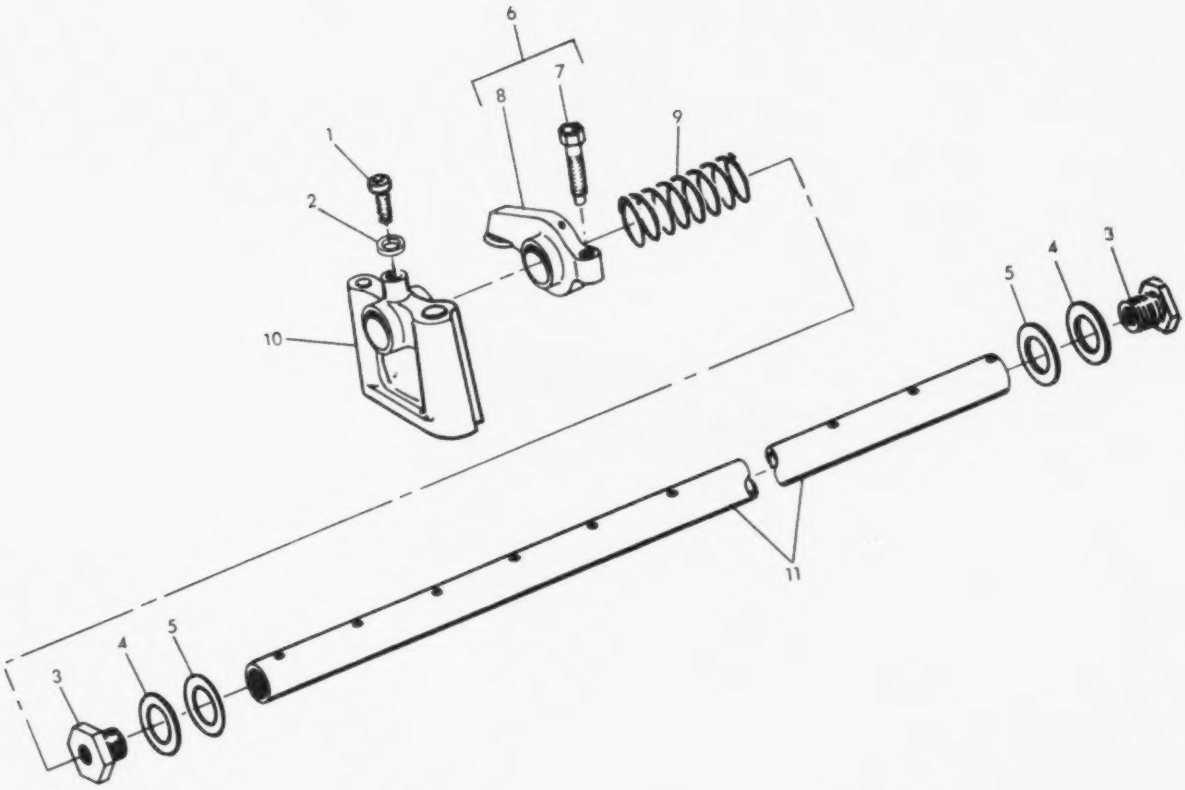
1. Screw
2. Washer
3. Cover
4. Gasket
5. Nut
6. Sleeve
7. Connector
8. Nut
9. Sleeve
10. Elbow
11. Tube
12. Nut
13. Sleeve
14. Elbow
15. Tube
16. Screw
17. Screw
18. Washer
19. Washer
20. Washer
21. Rocker arm shaft assy
22. Push rod
23. Screw
24. Eye
25. Cylinder head assy
26. Gasket
27. Gasket
28. Bolt
29. Screw
30. Washer
31. Gear
32. Key
33. Plate
34. Cam
35. Lifter

ME 6115-545-34/14-36 C7

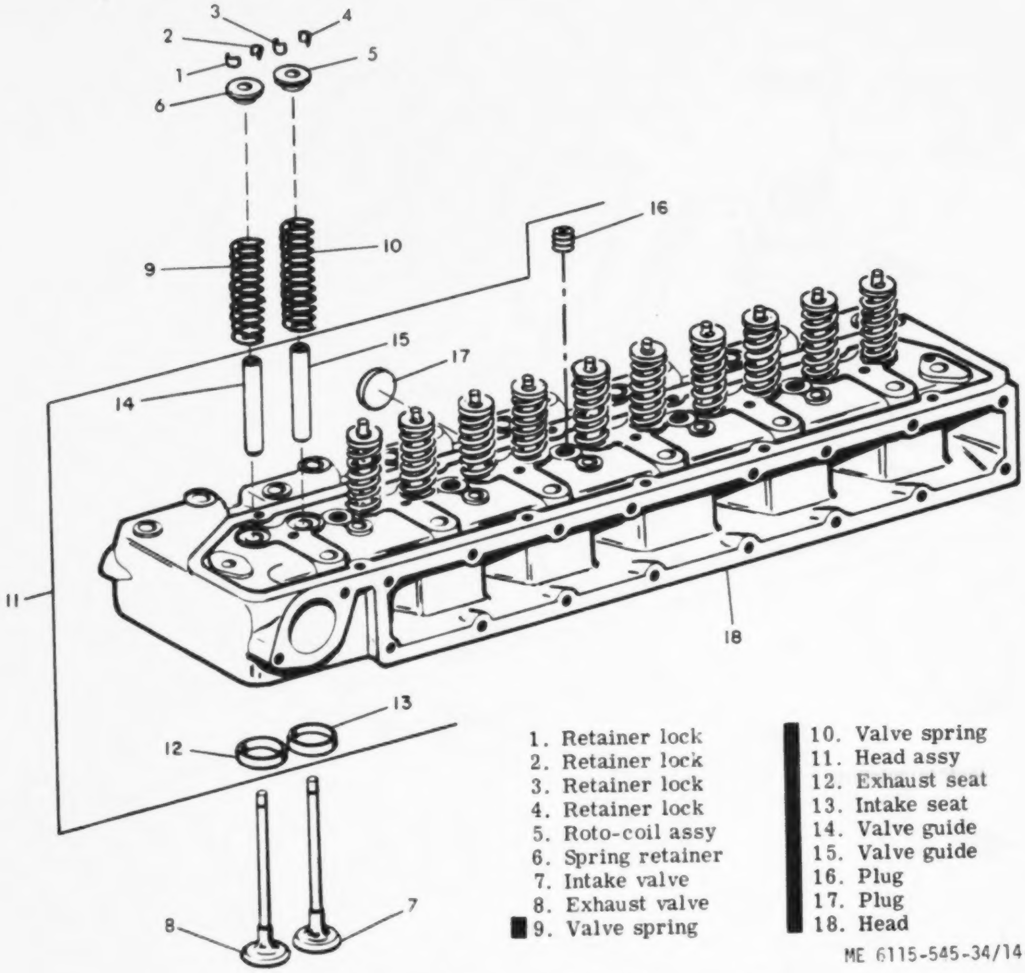
Figure 14-36. Cylinder Head and Valve Operating Mechanism



1. Screw
2. Washer
3. Plug
4. Washer
5. Washer
6. Rocker arm assy
7. Adjusting screw
8. Rocker arm
9. Spring
10. Bracket
11. Shaft

ME 6115-545-34/14-37

Figure 14-37. Rocker Arm Shaft Assembly



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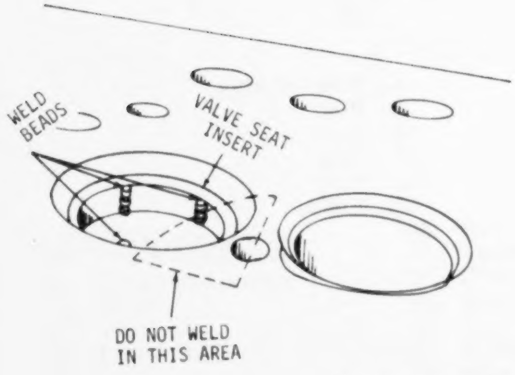
1. Retainer lock
2. Retainer lock
3. Retainer lock
4. Retainer lock
5. Roto-coil assy
6. Spring retainer
7. Intake valve
8. Exhaust valve
9. Valve spring
10. Valve spring
11. Head assy
12. Exhaust seat
13. Intake seat
14. Valve guide
15. Valve guide
16. Plug
17. Plug
18. Head

ME 6115-545-34/14-38 C4

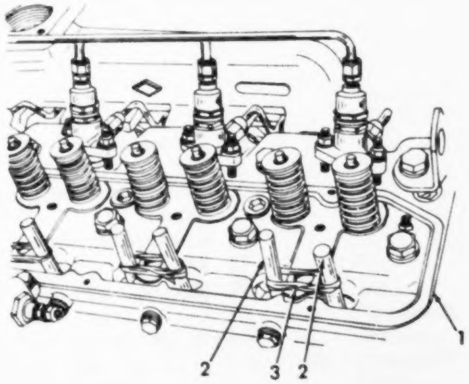
Figure 14-38. Cylinder Head Assembly



WELD BEADS
VALVE SEAT INSERT
DO NOT WELD IN THIS AREA

ME 6115-545-34/14-39

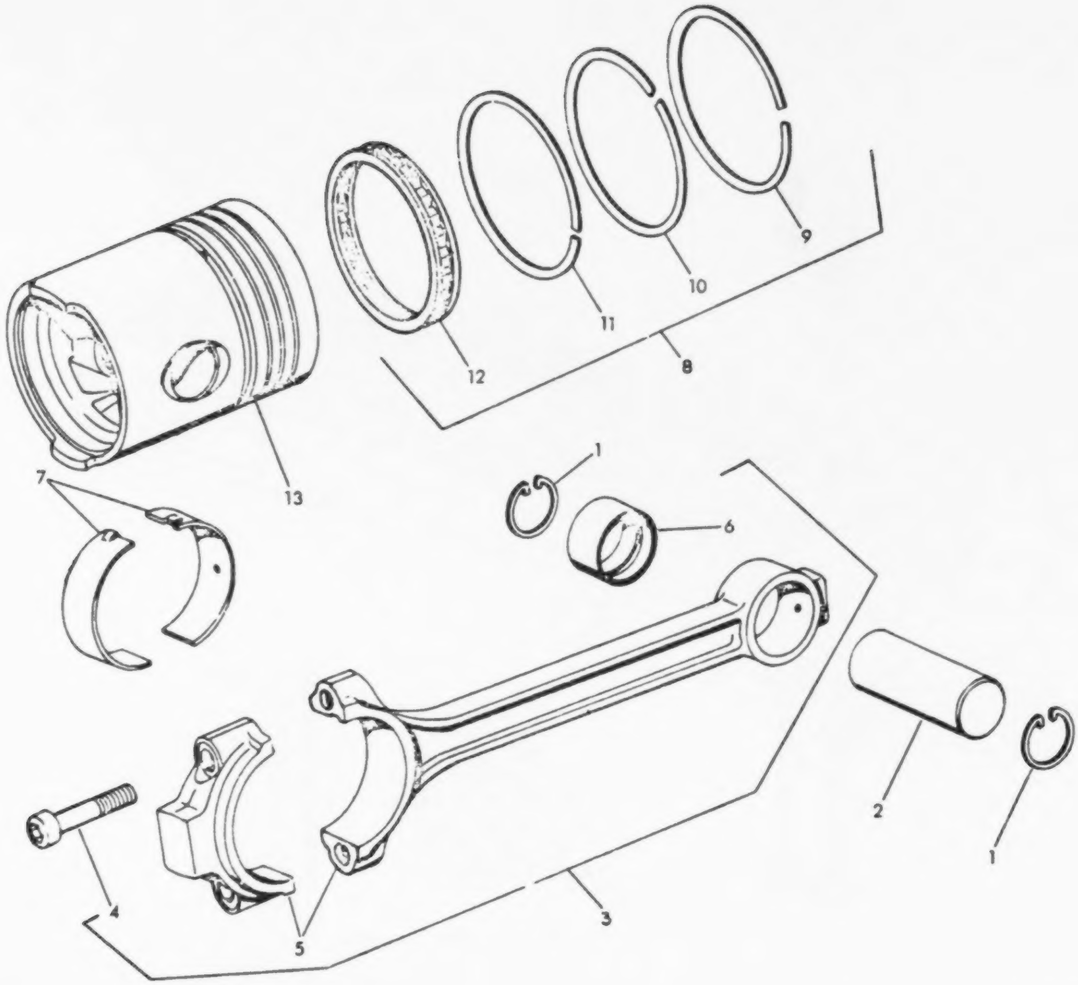
Figure 14-39. Valve Seat Insert Welding Details



1. Cylinder head
2. Wooden dowel rod
3. Rubber band

ME 6115-545-34/14-40

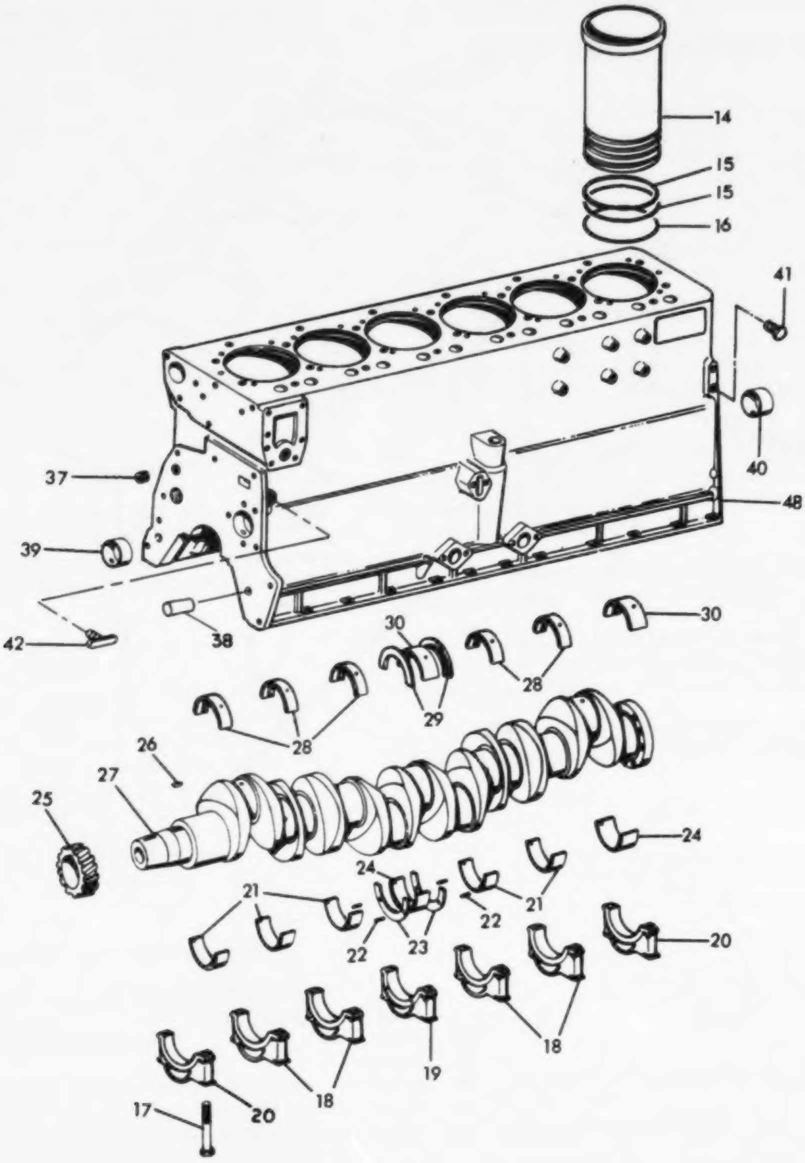
Figure 14-40. Installation of Wooden Dowels in Valve Lifters



1. Retainer
2. Pin
3. Connecting rod assy
4. Screw
5. Connecting rod
6. Bushing
7. Bearing
8. Ring set assy
9. Ring
10. Ring
11. Ring
12. Ring
13. Piston

ME 6115-545-34/14-41(1)

Figure 14-41. Piston, Crankshaft, and Block
(Sheet 1 of 3)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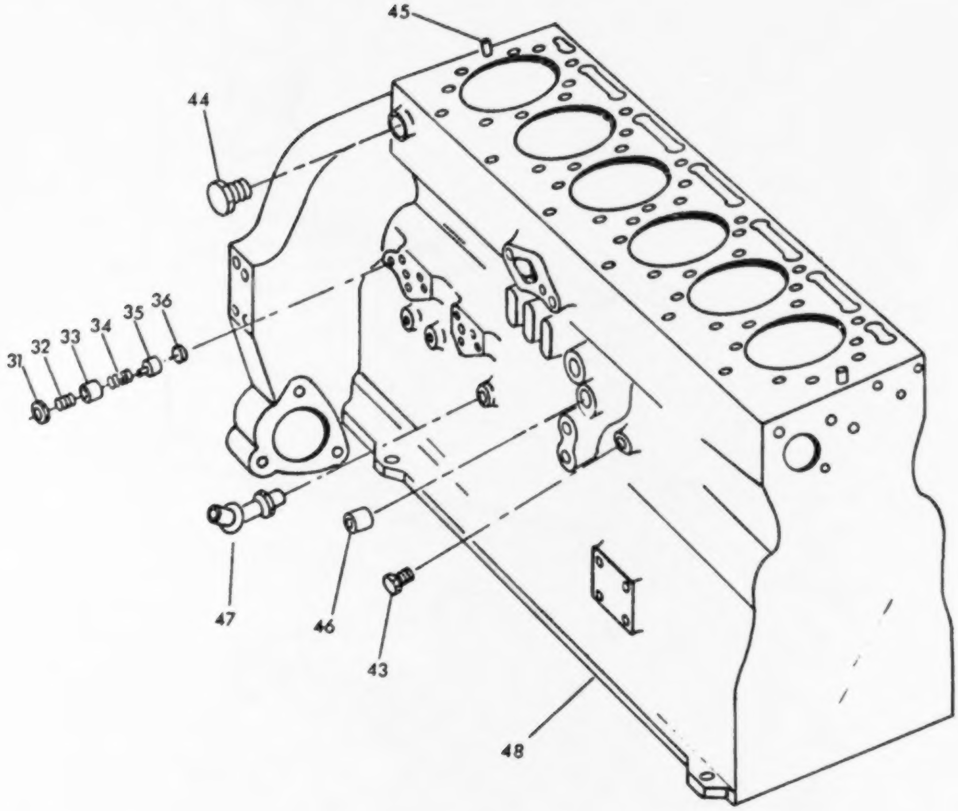
14. Sleeve
15. Preformed packing
16. Preformed packing
17. Screw
18. Front cap
19. Center cap
20. Rear cap
21. Main bearing
22. Pin
23. Thrust flange
24. Main bearing
25. Gear
26. Key
27. Crankshaft
28. Main bearing
29. Thrust flange
30. Main bearing
31. Jam nut
32. Valve adj. screw
33. Spacer
34. Spring
35. Piston
36. Insert
37. Plug
38. Pin
39. Camshaft bearing
40. Camshaft bearing
41. Plug
42. Valve

ME 6115-545-34/14-41(2) C4

Figure 14-41. Piston, Crankshaft, and Block
(Sheet 2 of 3)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43. Plug
44. Plug
45. Dowel
46. Plug
47. Pipe
48. Block assy

ME 6115-545-34/14-41(3)

Figure 14-41. Piston, Crankshaft, and Block
(Sheet 3 of 3)

at the top of insert seat. Thus, for the 30° exhaust valve face angle and a 1° interference angle, the insert seat grinder wheel must be dressed to grind the insert seat at an angle of 31°. Likewise, the insert seat for the intake valve must be ground at 31°. This is a positive interference angle. A negative angle must be avoided. The first step in reconditioning a seat or insert is to grind the seat, removing only enough metal to produce a pit-free continuous seat. After the seat has been ground, use a dial gauge to check concentricity of the seat relative to the valve guide. The total run-out of a good seat should not exceed 0.002 inch total indicator reading.

(3) To determine seat contact in relation to insert and valve face, wipe a thin film of Prussion Blue on the valve face and bounce the valve once on the valve seat. A thin, continuous line must be evident on the valve face, otherwise further grinding is required.

NOTE

Do not revolve valve while checking seat.

(4) The width of the valve seat on both the exhaust and service intake inserts is 3/32 inch. If the seats are too wide or too narrow they must be ground to the proper width using the appropriate angle grinding wheels.

CAUTION

After valves are installed in cylinder head, make certain the exhaust valve heads are set in a minimum of 0.053 inch and the intake valve heads are set in a minimum of 0.054 inch from the cylinder head gasket surface, otherwise, serious damage will result. If valve stand-in is less than the allowable amount, the valve seat must be ground lower until the allowable stand-in is obtained.

e. Rocker Arm, Shaft Inspection and Repair.

(1) Inspect end of rocker arm adjusting screws and end of rocker arms. If they are worn, the rocker arm assemblies must be replaced.

(2) Inspect rocker arm shaft bore for wear. The bore of the rocker arm bore is 0.001 to 0.002 inches and the outer diameter of the rocker arm shaft is 0.999 to 1.000 inch. The clearance of the rocker arm shaft to the rocker arm is 0.001 to 0.003 inch and must not exceed 0.005 inch. If rocker arm shaft bore is excessively worn, the rocker arm assemblies must be replaced.

NOTE

Bushings are non-replaceable in rocker arm assemblies.

(3) Inspect rocker arm shaft for wear and replace if necessary. Clean oil holes in rocker arms and rocker shaft with solvent, Federal Specification P-D-680, a small wire, and compressed air.

(4) Inspect both ends of push rods for signs of wear. Polish out nicks or scores. If pushrods are bent, twisted, or damaged, replace push rods.

f. Camshaft, Camshaft Gear and Valve Lifter Inspection.

(1) The outer diameter of all camshaft bearing journals is 2.130 to 2.131 inches. The inside diameter of the camshaft bearings, when installed, is 2.133 to 2.136 inches. The clearance between the camshaft journals and bearings is 0.002 to 0.006 inch and must not exceed 0.008 inch. If exceeded then the bearings must be replaced. If the installation of new standard bearings does not reduce the end clearance to less than 0.008 inch, it is recommended to grind the camshaft journals to accommodate 0.010-inch undersize bearings. Likewise, if the journals are worn or scored to the extent that they will not accommodate 0.010-inch undersize bearings, the camshaft must be replaced.

(2) Inspect the intake and exhaust lobes of the camshaft for roughness, scoring or excessive wear. Replace the camshaft if any of these conditions are found to exist.

(3) Inspect camshaft gear for nicked, scored, or broken teeth. Replace as necessary.

(4) Inspect thrust plate for wear. Replace if the wear area is rough or the wear is excessive. New thrust plate thickness is 0.204 to 0.206 inch.

(5) Inspect valve lifters for excessive wear. Replace a set of lifters if one or more show excessive wear.

14-79. Reassembly and Installation.

a. Valve Lifter Installation.

(1) Lubricate valve lifters with clean engine oil and install them in their original positions in the cylinder block.

(2) Using the wooden dowel method illustrated in figure 14-40, pull the lifters up so they do not interfere with camshaft installation.

b. Camshaft and Camshaft Gear Installation.

(1) Place the camshaft in a press with the shoulder of the first journal resting on parallel bars.

(2) Position the thrust plate on camshaft.

(3) Heat the gear in oil to a temperature of 350° - 400° F.

(4) Using asbestos gloves, position the gear on the camshaft and align the gear keyway with the key in the camshaft.

(5) Press the gear onto the shaft until the gear hub is flush with the front end of the camshaft.

(6) Check the clearance between the thrust plate and bearing journal. The end play clearance is .0027 to 0.0083 inch.

(7) Check camshaft journal to bearing running clearance.

(8) Oil the camshaft bearings in the cylinder block and carefully insert the camshaft. Be careful not to scratch or mar the camshaft bearings.

(9) Before camshaft is completely inserted in cylinder block, position thrust plate in place.

NOTE

Make certain the timing marks on camshaft gear and crankshaft gear are aligned when camshaft is installed (fig. 14-25).

(10) Install the capscrews through the thrust plate. Tighten the capscrews to a torque of 18 to 20 foot-pounds.

(11) Check the camshaft gear backlash. The backlash between the mating gears of the crankshaft and the camshaft is 0.0015 to 0.009 inch. The backlash between the mating gears of the hydraulic pump and camshaft is 0.003 to 0.011 inch.

c. Cylinder Head Reassembly and Installation.

(1) Make certain that the machined surfaces of the cylinder block and the cylinder head are thoroughly clean. A new cylinder head gasket must be used before installing the cylinder head.

CAUTION

Before the cylinder head is installed, make certain that there is not an excessive amount of oil, or any other liquid, in the capscrew holes in the cylinder block. Too much oil in any of these holes may cause a hydrostatic lock and crack the cylinder block when the capscrew is tightened.

(2) Thoroughly clean top deck of cylinder block and underside of cylinder head.

(3) Make certain that the cylinder sleeve standout is within the specified limits. The standout of each cylinder sleeve is 0.002 inch to 0.005 inch above the top flat surface of the cylinder block.

NOTE

Correct standout, if necessary, by reconditioning sleeve seat in the block and installing sleeve shims under cylinder sleeve flange to obtain the 0.002-inch to 0.005-inch protrusion.

(4) Install a new cylinder head gasket over the two dowel pins and onto the cylinder block with the indicated side down, as stamped on the gasket. Do not use any sealer or gasket dope. The gasket as supplied has been pre-coated with a phenolic sealer and an anti-stick compound.

(5) Use a sling and position the cylinder head over the dowel pins and onto the cylinder block.

(6) Lubricate threads of 20 short cylinder head capscrews with light coat of engine oil and install with hardened washers in cylinder head. Tighten capscrews to 90 to 110 foot-pounds following sequence shown in figure 14-42. (Section A).

(7) Tighten the 20 cylinder head capscrews in the numerical sequence in figure 14-42, Section A to 155-165 foot-pound torque.

CAUTION

Torque figures in this and following steps are based on engine oil lubricated threads and under capscrew heads. To prevent overstressing of capscrew, use engine oil only. Other lubricants may cause extreme pressure.

(8) Position rocker arms, shaft, and brackets assembly on cylinder head and align rocker arm adjusting screws in the push rod cup ends. Install the six long capscrews; also install the six 3/8 inch capscrews and lockwashers in the rocker arm brackets. Tighten the long capscrews, starting at the center of the head and working alternately towards each end, to a torque of 90-100 foot-pounds and the 3/8 inch capscrews to a torque of 28-33 foot-pounds.

NOTE

Lubricate threads and under capscrew heads with a light coat of engine oil before installing.

(9) Tighten the 26 cylinder head capscrews in the numerical sequence in figure 14-42 to 155-165 foot-pounds torque.

(10) Tighten the 6 cylinder head capscrews in the numerical sequence in figure 14.42 (Section B). Torque capscrews to 155-165 foot-pounds.

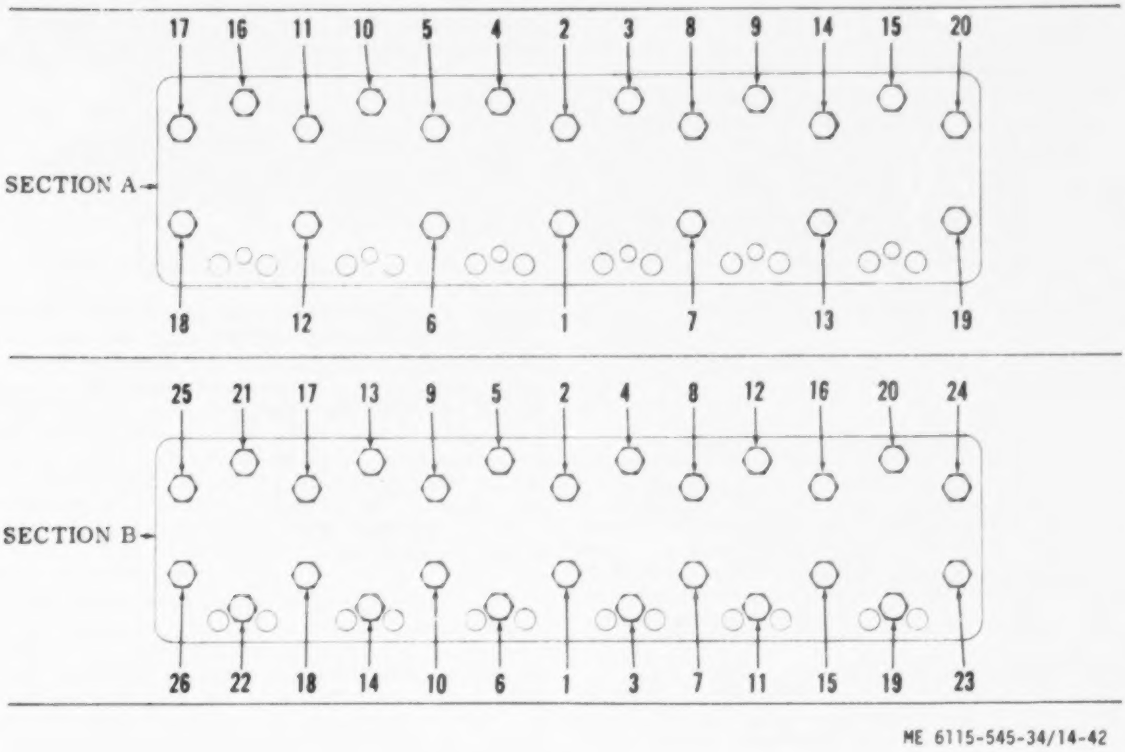

Figure 14-42. Cylinder Head Capscrew Locations and Torquing Sequence

(11) Adjust all intake and exhaust valves to a cold tappet clearance setting of 0.018 inch.

(12) Connect the oil feed tube to the fitting in the cylinder head and install cylinder head cover and gasket.

(13) Replace engine valve cover, tachometer drive, adapter, overspeed switch, manifolds, exhaust pipe, radiator, cooling hoses, turbocharger, and engine area panels. Refer to Operator and Organizational Maintenance Manual.

(14) Fill the cooling system. Run engine for approximately one hour, perferably under load, with a minimum coolant temperature of 160°F. Inspect engine for leaks.

(15) Remove valve cover and rocker shaft assembly from cylinder head to gain access to the 20 capscrews securing the cylinder head.

(16) Retighten the 20 capscrews to 155-165 foot-pounds torque following the sequence depicted in figure 14-42 section A. If capscrew does not move when this specified torque is reached, back off slightly by loosening, the retighten to specified torque. This is important in eliminating possible false torque readings due to temporary thread seizure.

(17) Position rocker arms, shaft and brackets assembly on cylinder head and align rocker arm adjusting screws in the push rod cup ends. Install the six long capscrews; also install the six 3/8 inch capscrews and lockwashers in the rocker arm brackets. Tighten the long capscrews to 90-110 foot-pounds and the 3/8 inch capscrews to a torque of 28-33 foot-pounds following this sequence depicted in figure 14-42, section B.

(18) Retighten the 6 long capscrews to 155-165 foot-pounds following the sequence depicted in figure 14-42, Section B. Retighten the 3/8 inch capscrews to maintain a torque of 28-33 foot-pounds per capscrew.

## Section XVI PISTON AND RINGS

### 14-80 General.

The pistons are tin-plated aluminum alloy and are precision machined, cam gound and balanced. Each piston is fitted with a nickel alloy top ring insert. Three compression rings and one oil control ring are located above the piston pin. The top compression ring and the two scraper segments of the three-piece oil rings are chrome plated. Holes drilled through the walls of each piston at the oil ring groove allow excess oil collected in the groove to return to the oil pan. Piston pins are the full floating type, held in the piston by retainer rings. A connecting rod and bearing connects each piston to the crankshaft.

### 14-81 Piston, Rod, and Rod Bearing Removal and Disassembly.

a. Symptoms and Isolation of Malfunction. A malfunction of a component of the piston assembly is usually indicated by loss of engine power, increased oil consumption, bluish-white exhaust smoke, excessive engine knock, or low oil pressure.

b. Removal and Disassembly.

(1) Remove engine assembly. (para. 2-13).

(2) Support engine on block or engine stand.

(3) Remove cylinder head (para. 14-77).

(4) Drain engine oil, and remove the oil pan, oil pump and discharge tube (para. 14-65).

(5) Remove the piston ring travel ridge from the cylinder sleeve. (para. 14-85).

(6) Remove the lock bolts securing the connecting rod bearing caps. (See fig. 14-41). Remove the bearing caps and free the lower end of the rods from the crankshaft. Remove the shells from the bearing.

(7) Carefully remove each piston and rod assembly by pushing the assembly out through the top of the cylinder sleeve.

(8) Remove the pin retainer from the groove in the piston at each end of the piston pin.

(9) Remove the rings from each piston.

**CAUTION**

> Whenever a connecting rod with the piston is secured in a vise, be extremely careful that the bottom of the piston skirt is not nicked. Use lead jaw protectors to protect the bottom of the skirt from nicks and to prevent nicks in the rod which will lead to piston and/or connecting rod failure.

(10) Drive the piston pin from the piston. Immerse piston in $180^{\circ}$F water for approximately 5 minutes. Remove pin while piston is still hot.

NOTE

> The bore in an aluminum alloy piston expands as the piston heats but provides a tight fit between pin and piston at room temperature.

### 14-82 Piston Assembly Inspection and Repair.

a. Clean pistons with cleaning solvent, Federal Specification P-D-680, and dry them with clean, compressed air. After cleaning, the piston skirt, piston rings, and ring grooves should be thoroughly inspected. Be sure oil drain holes in the oil ring grooves are open and clean. If the cleaning solution does not remove all carbon from the bottom of the ring grooves, break the old rings in half and use the butt ends as scrapers. Be careful to remove only carbon or foreign material; do not scrape away any metal from the side or bottom of the ring grooves.

b. The piston skirt should be examined for score marks or other indications of improper piston clearance. Inspect the inside of pistons for cracks; scored or cracked pistons should be replaced. Check pistons for wear. The skirt diameter of a new piston is 4.246 - 4.247 inches (measured at right angles to piston pin and at bottom of the skirt); the inside diameter of a new cylinder sleeve is 4.2495 - 4.251 inches, giving a running clearance of 0.0025 - 0.005 inch.

c. Any deviation from these measurements will indicate the amount of wear on the piston and/or the cylinder sleeve. If the piston assembly and piston rings are removed from the cylinder sleeve, even after a short period of operation, do not reinstall the same rings; in most cases, used rings will not again seat properly. The outer diameter of new piston rings have tool marks and reasonably rough surfaces which allow for a fast wear-in and seating of the rings to the cylinder walls. After a period of operation, the rings wear or lap themselves to fit perfectly with the cylinder walls and rings seat.

d. If the wear in the piston compression ring grooves does not create side clearance with new piston rings greater than 0.011 inch, if piston pin bore does not exceed 1.5026 inches, and if no cracks or scores are detected in piston pin bosses, on the skirt or in the combustion chamber area, the pistons may be reused with a reasonable life expectancy of one-half to three-fourths that of new pistons.

e. Inspect the bore of connecting rod with cap in place and the nuts tightened to 80 to 85 foot-pounds. Using an inside micrometer, measure dimensions A and B as shown in figure 14-43. Record dimensions

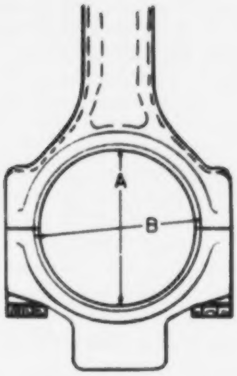

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Figure 14-43. Connecting Rod, Crankshaft End

A and B and arrive at an average dimension. The average dimension must not exceed 2.9705 inches. Subtract dimensions A and B and the remainder must not exceed 0.0015 inch, which is the maximum allowable out-of-roundness.

CAUTION

Avoid causing nicks and other physical damage to the I-beam section of the connecting rod. Do not clamp I-beam section of rod in a vise. Whenever connecting rod is clamped in a vise, use lead jaw protectors and clamp rod on the crankshaft end only.

f. Measure outside diameter of the piston pin to determine amount of wear. Outer diameter of a new piston pin is 1.5011 to 1.5013 inches. The bore of the connecting rod bushing is 1.5027 to 1.5032 inches. These dimensions of pin and bushings provide a running clearance of 0.0014 to 0.0021 inch. Replace the connecting rod bushing if clearance exceeds 0.002 inch.

g. Inspect connecting rod for cracks by the magnetic particle wet fluorescent continuous method.

h. Magnetication must be performed longitudinally (between the heads) using a minimum current of 2000 amperes and, transversely, (in the coil) using a minimum current of 800 amperes. A minimum of two applications of current of approximately one-half second duration in each position should be made. Apply indicating solution gently and uniformly to all portions of the part while the magnetizing current is flowing.

i. Inspect threads of connecting rod and lock bolts. If damaged, they must be replaced.

j. Check alignment, length and twist of connecting rod, using a checking fixture. The checking fixture must first be calibrated as follows:

(1) Select a new connecting rod that has been checked for correct nominal length of 8.500 inches. The length of a new connecting rod (center-to-center of bores) is 8.498 to 8.502 inches.

(2) Lubricate threads of connecting rod bolts with engine oil and assemble cap to connecting rod. Tighten bolts alternately to torque of 80-85 foot-pounds.

(3) Install pin and crank mandrels in connecting rod. Center crank mandrel in crankshaft end so the expanding pin is located in bottom of bore near the center of rod cap. Tighten expanding pin snugly.

(4) Place rod with mandrels in checking fixture.

(5) Adjust dial indicators until their hands move approximately one revolution while resting on pin mandrel.

(6) Adjust indicator faces to zero.

(7) Remove connecting rod and mandrels as an assembly from checking fixture, turn rod horizontally 180° and carefully place back in fixture. Readjust indicator faces so the zero position is halfway between original zero reading and the new reading. The fixture is now calibrated.

(8) Carefully remove connecting rod and mandrels as an assembly from checking fixture.

k. Check connecting rod alignment as follows:

(1) Lubricate threads of connecting rod bolts with engine oil and assemble cap to connecting rod that is to be checked. Tighten bolts alternately to specified torque of 80 to 85 foot-pounds.

(2) Install pin and crank mandrels in connecting rod. Center crank mandrel in large bore so the expanding pin is located in bottom of bore near the center of rod cap. Tighten expanding pin snugly.

(3) Carefully place rod with mandrels in checking fixture and record indicator readings.

(4) Remove connecting rod and mandrels as an assembly from checking fixture; turn rod horizontally 180° and carefully replace in fixture. Record the new indicator readings.

(5) The maximum allowable bend in the rod is a combined total gauge reading of 0.004 inch. Calculate the differences in the individual indicator gauge recorded readings between step (3) and step (4) above. Then add the two to get the combined total gauge reading.

NOTE

> Straightening of used rods that are bent beyond 0.004 inch and up to a maximum of 0.030 inch is acceptable. Bridge the rod to be straightened at the pin and crank ends and bend rod in the center of the I-beam section. Do not nick or indent the rod surfaces during this operation. Always bend beyond the straight position and then bend back to the straight position. A hydraulic press or fixture can be satisfactorily used for this operation.

(6) The twist of the connecting rod can be checked with a feeler gauge between the pin mandrel and fixture face. A twist up to 0.010 inch maximum is acceptable.

l. Make certain oil hole in connecting rod is clean and free of foreign matter. Blow dry compressed air through oil hole.

m. Inspect connecting rod bearing shells for scoring, chipping, corrosion, cracking, or signs of overheating; discard bearing shells if any of these conditions are apparent. The backs of bearing shells should be inspected for bright spots and discarded if any bright spots are found; this condition indicates that bearing shells have been moving in their supports.

n. Inspect rod bearing shells for wear. The bore of bearing shells is 2.7495 to 2.7510 inches installed and with connecting rod bolts tightened to the specified torque of 80 to 85 foot-pounds. This provides a running clearance of 0.001 to 0.0035 inch. New bearing shells must be installed when this clearance exceeds 0.008 inch.

o. Measure connecting rod bearing shells for wear with a micrometer at several places away from the parting line. Bearing shells, when in place, are 0.0004 to 0.001 inch larger in diameter for a distance of 3/8 inch each side of the parting line than they are 90° from the parting line. Connecting rod bearings have a thickness of 0.10975 to 0.11025 inch. Shells measuring less than 0.108 inch should be discarded and new ones installed. In the event that the crankshaft is worn or damaged and must be ground, bearing shells 0.002 inch, 0.010 inch, 0.020 inch and 0.040 inch undersize are available.

NOTE

> Install new bearing shells if the fit is unsatisfactory. The crankshaft must turn freely after all the connecting rod cap bolts have been tightened to torque of 80 to 85 foot-pounds.

p. Replace rod bearings if they have been removed and have given 2000 hours or more service. Always replace rod bearings when rebuilding engine at depot maintenance level.

q. If the connecting rod bushing is worn, it must be pressed out and a new bushing pressed into the connecting rod. When new bushing are installed, be sure the bushing oil hole lines up with the connecting rod oil hole. The outer diameter of a new piston pin is 1.5011 to 1.5013 inches and the bore of the bushing is 1.5027 to 1.5032 inches. These dimensions provide a running clearance of 0.0014 to 0.0021 inch between the pin and bushing. It is necessary to ream the connecting rod bushing to obtain this clearance. The bore in the piston for the piston pin is 1.5014 to 1.5016 inches. These dimensions provide a fit of pin in piston at room temperature of 0.001 inch loose to 0.0005 inch loose.

## 14-83. Piston, Rod, and Rod Bearing Reassembly and Installation.

CAUTION

> When installing rings on pistons, do not spread the rings more than necessary. Whenever a connecting rod with the piston is secured in a vise, be extremely careful that the bottom of the piston skirt is not nicked. Use lead protective jaws to protect the bottom of the skirt from nicks and also to prevent nicks in the rod which will lead to piston and/or connecting rod failure.

a. Install the three piece oil control ring as follows:

(1) Place stainless steel expander spacer of three-piece ring in the bottom groove of the piston with the ends butted.

(2) Install chrome-plated steel segment on bottom side of expander spacer, with gap of segment approximately 90° beyond gap of expander spacer, making certain expander spacer is still in a butted position.

(3) Install second segment on the top side of expander spacer with segment gap approximately 90° from expander spacer gap in opposite direction from which the bottom segment has been installed.

b. Install the three compression rings. The gap of all rings must be positioned 180° apart and in line with the piston pin holes.

c. Recheck the three-piece ring assembly. Rings should be free to move in the grooves; however, a slight drag will be evident because of the side sealing action of the ring assembly. Be sure expander spacer remains in butted position.

NOTE

> Pistons must be fitted to their respective cylinder sleeves before the piston rings are installed to provide a running clearance of not less than 0.0025 inch. Insufficient clearance will result in premature failure of pistons and/or cylinder sleeves. Measurements must be taken at room temperature.

d. Using an inside micrometer, measure the bore of the cylinder sleeve. Using an outside micrometer, measure the outer diameter of the piston skirt at the right angle to the piston pin and at the bottom of the skirt. The difference between the two readings is the running clearance.

e. The gap between ends of piston rings should be measured before rings are installed on pistons. Insufficient end gap can cause scored rings and scored cylinder sleeves. Check the ring gap by inserting each ring into the cylinder sleeve in which it is to be used. Use a piston to push ring squarely down in the bore of the cylinder sleeve and far enough to be on the ring travel area. Check ring gap with a feeler gauge. The ring end gaps, using cylinder sleeves of 4.2495 - 4.251 inches bore are:

| | |
|---|---|
| Top compression ring | 0.013-0.027 inch |
| Center rings | 0.013-0.024 inch |
| Oil control ring (3 pc.) | 0.013-0.024 inch |

CAUTION

The piston rings should never be filed to open the gap because the chrome plating might be loosened by the file and later distributed through the engine causing damage or scoring of the piston and the cylinder sleeve.

f. Measure ring-to-groove clearance (top of ring to top of groove in piston). The ring to groove clearances, using a new piston and new rings, are as follows:

| | |
|---|---|
| Top compression ring | 0.0040-0.0060 inch |
| Center rings | 0.0020-0.0040 inch |
| Oil control ring (3 pc.) | 0.0005-0.0030 inch |

g. Install one of the piston pin retainers in one end of the piston pin hole in the piston.

h. Insert upper end of connecting rod into piston.

CAUTION

When assembling piston to connecting rod, make certain top of piston stamped CAMSHAFT SIDE is toward side of connecting rod stamped with numbers identifying the cap with upper portion of rod.

i. Lubricate piston pin with clean oil and, with a piston pin remover and installer tool tap piston pin into piston and connecting rod.

j. Install the other piston pin retainer at the opposite end of the piston pin bore.

NOTE

After piston rings have been properly fitted, lubricate piston and rings with engine oil. Install second and third rings on piston (with side marked "Top" or "T" toward top of piston), using a piston ring remover and installer tool. Top ring may be installed with either side toward top.

Install each piston, with rings and connecting rods, as an assembly. The lower end of each connecting rod, as well as the connecting rod bearing caps, are number 1, 2, 3, etc. for identification. They must be installed in the corresponding numbered cylinder with the numberedside of rod toward the camshaft side of engine.

k. Stagger piston rings gaps 180° apart and in line with piston pin holes, and apply clean engine oil to pistons and rings. With a piston ring compressor (piston inserted), install the piston and connecting rod in the cylinder sleeve by pressing on top of piston with wooden hammer handle. If any difficulty is encountered, however slight, the piston inserted must be removed and ring set inspected for correct installation in piston grooves. Align lower end of connecting rod with crankshaft before inserting piston into cylinder.

l. Lubricate and install a bearing shell in position in connecting rod, with tang of bearing shell in the corresponding slot in connecting rod, and position rod on crankshaft journal.

CAUTION

Make certain the backs of the bearing shells are free from dirt and grit particles.

m. Lubricate and install a bearing shell in position in the connecting rod bearing cap, with tang of bearing shell in corresponding slot in bearing cap. Install bearing cap and shell, making certain identification number stamped in the bearing cap is located on the same side as corresponding number stamped in the connecting rod.

n. Prior to installation, thoroughly clean and dry with compressed air all of the connecting rod capscrews (lock bolts).

o. Install an oil lubricated piston and connecting assembly, minus bearing cap but with upper bearing shell in place, in engine.

NOTE

Do not allow the rod to scratch the cylinder bore nor let it strike the crankshaft webs or thrust faces when pushing rod into place on the crankpin.

p. Check rod and cap index numbers for position and correctly assemble cap, with lower bearing shell in place, to the rod.

q. Generously coat the capscrew threads and their underhead areas with engine lubricating oil.

r. Install connecting rod capscrews and tighten to 8-12 foot-pounds torque, (the socket head capscrews require a male 3/8 inch hex wrench).

s. Using a plastic head hammer and striking the connecting rod cap on its balance pad only, align the cap to the rod by driving it first against the crankpin forward web and then against the crankpin rear web.

t. Tighten both capscrews to approximately 1/2 torque (40 - 43 foot-pounds) and then to full torque (80 - 85 foot-pounds).

u. Check connecting rod side clearance. Correct clearance is 0.005 to 0.010 inch.

v. Install oil pump and oil pan. (para 14-67.)

w. Install cylinder head. (para 14-79.)

x. Install engine assembly. (para 2-14.)

## Section XVII. CRANKSHAFT AND CYLINDER BLOCK

### 14-84. General.

a. The cylinder block is the main structural part of the engine. It is cored to receive removable wet-type cylinder sleeves. The cylinder sleeves are completely surrounded by water jackets which extend the full length of the cylinder walls for maximum cooling.

b. The seven-bearing, counterbalanced crankshaft converts the vertical power strokes of the pistons to a rotational torque that can be applied to the generator through the flywheel.

c. The six camshaft bearings which support the camshaft are mounted in the cylinder block. These bearings are easily accessible when the piston assemblies, connecting rods, cylinder sleeves and crankshaft are removed.

### 14-85. Crankshaft, Cylinder Sleeves and Camshaft Bearings Removal.

a. Crankshaft Removal.

(1) Refer to Operator and Organizational Maintenance Manual for removal of the housing, radiator, electric starter, winterization kits (if installed), turbocharger, and manifolds.

(2) Remove oil pan and oil pump. (para 14-65.)

(3) Remove flywheel housing and flywheel. (para 14-69.)

(4) Remove crankshaft pulley and vibration dampener. (para 14-61.)

(5) Remove timing gear housing, crankshaft gear and engine front plate. (para 14-72.)

(6) Remove connecting rod bearing caps. (para 14-81.)

NOTE

Identify connecting rod caps as to their original location on the connecting rods, and in the cylinder block in the event inspection proves they can be reused. Cylinder number is marked on the camshaft side of each rod and rod cap.

(7) Remove two capscrews on each main bearing cap and remove main bearing caps and lower main bearing shells. (fig. 14-41.)

(8) Remove crankshaft.

(9) Remove upper main bearing shells from cylinder block.

b. Cylinder Sleeves Removal.

(1) If the sleeves are to be reused, insure that the ridge above the ring travel is removed with a hone or a ridge removing tool. Insure that the glaze in ring travel area is removed with a cylinder hone or glaze breaker tool. Hone the sleeve to a cross hatch pattern at angles of 22 to 32° to a plane perpendicular to the bore axis. The cross hatch should be nearly uniform in both directions. Do not over-hone; stop when glazed area is removed. Thoroughly clean the sleeve with warm water and common laundry detergent and scrub the bore with a stiff bristle brush. Dry the sleeve with compressed air and inspect the bore to see that it is not oversize. After cleaning protect the bore of the sleeve with a thin coating of engine lubricating oil.

CAUTION

If the cylinder sleeve was honed while installed in the cylinder block, clean the block thoroughly to make certain that all abrasive material is removed.

(2) Refer to Operator and Organizational Maintenance Manual and remove housing, radiator, electric starter winterization kits, (if installed), turbocharger, manifolds, and valve cover.

(3) Remove cylinder head and valve operating mechanism. (para 14-77.)

(4) Remove piston and connecting rod assemblies. (para 14-81.)

(5) Remove cylinder sleeves. (fig. 14-41.)

(6) Remove all dirt, carbon, and oil from cylinder sleeves and from the machined recess and bore in cylinder block.

c. Camshaft Bearings Removal.

(1) Refer to Operator and Organizational Maintenance Manual and remove housing, radiator, electric starter, winterization kits (if installed), turbocharger, manifolds, and valve cover.

(2) Remove cylinder head and valve operating mechanism. (para 14-77.)

(3) Remove piston and connecting rod assemblies. (para 14-81.)

(4) Remove crankshaft and cylinder sleeves (refer to paragraphs (a) and (b) above).

(5) Drive camshaft bearings from block. (fig. 14-41.)

### 14-86. Crankshaft, Cylinder Sleeves, Camshaft Bearings and Cylinder Block Cleaning, Inspection and Repair.

a. Crankshaft.

(1) Clean crankshaft thoroughly and inspect the journals for scoring, chipping, cracking, or signs of overheating. If crankshaft has been overheated (usually indicated by discolored or blue bearing journal surfaces), or is scored or excessively worn, reconditioning or replacement will be required. Examine bearing journals for cracks if overheating has occurred. (fig. 14-41.)

(2) Measure the crankshaft main bearing and connecting rod journals at several places on their diameter to check for roundness. The diameter of main bearing journals is 3.2465 to 3.248 inches; connecting rod journals is 2.747 to 2.7485 inches. The only recommended method of reconditioning the crankshaft is regrinding, as required, to accommodate undersize bearing. Chrome plating or metallizing the bearing journals is not acceptable.

(3) All main and connecting rod bearing journal surfaces of the crankshaft are hardened to a minimum depth of approximately 0.060 inch. If regrinding of crankshaft journals becomes necessary, the work should be done by a reputable machine shop that has suitable equipment to handle precision work of this type. Main bearing shells 0.002, 0.010, 0.020 and 0.040 inch undersize are available. If crankshaft is ground, the diameter of main bearing journals should be reduced in steps of 0.002, 0.010, 0.020, or 0.040 inch below 3.2465 to 3.248 inches to fit the undersize main bearing shells.

(4) If out-of-round or taper of journals exceeds 0.002 inch, crankshaft must be reground to a standard undersize or replaced.

(5) Blow out all oil passages in crankshaft with dry compressed air.

(6) Any bearing shells that are scored, chipped, pitted, or worn beyond the specified limits given below must be replaced. Inspect backs of the shells for bright spots. Bright spots on backs of the shells indicate shells have shifted in their supports and are unfit for further use.

(7) The clearance between main bearing shells and the crankshaft journals is 0.0019 to 0.0046 inch. New bearing shells must be installed when this clearance exceeds 0.008 inch.

(8) With crankshaft removed, measure inside diameter of the bearing at a point 90° from the parting line, with bearing cap installed and tightened to 170-190 foot-pounds. Bearing shells when in place are 0.002 to 0.004 inch larger in diameter at the parting line than they are 90° from the parting line, and do not form a true circle. The two halves of the shells have a crush fit in their bore in the block and must be tight when the cap is secured in place. Do not measure inside diameter at the parting line.

(9) The bore of new main bearings installed is 3.2499 to 3.2511 inches and any reading above 3.2511 inches indicates the amount of bearing wear. Measure diameter of the crankshaft journal at the corresponding bearing location and subtract this dimension from inside diameter measurement of the bearing (as determined above); the difference between these two measurements is the crankshaft-to-bearing clearance.

(10) Another method for determining amount of wear on bearing shells is by measuring each shell with a micrometer at a point of 90° from the parting line. New (standard size) shells, should measure 0.1549- to 0.1554-inch thick. Bearing shells less than 0.153-inch thick are worn beyond the allowable limits and must be replaced.

(11) The most accurate method of determining main bearing clearance is by using micrometer, as described in the preceding paragraphs. However, if the proper size micrometers are not available or the crankshaft is installed in the engine, bearing clearance must be measured by using a plastic strip manufactured for this purpose. The plastic strip must be used in accordance with the manufacturer's instructions.

b. Cylinder Block and Cylinder Sleeves.

(1) Thoroughly clean the bores in cylinder block for the sleeve. Make certain bottom surface of flange on cylinder sleeve and the counterbore in cylinder block are clean and free from nicks or burrs.

(2) Before installing the new sleeves, use warm water and common laundry detergent and scrub the bore with a stiff bristled brush to insure cleanliness and removal of any possible hone dust from the pores. Dry and protect with a thin coating of engine lubricating oil.

(3) Before installing packing rings on sleeve, insert sleeve into bore of cylinder block to make sure sleeve can be pushed down into place and turned in the bore by hand pressure. If the sleeve cannot be inserted and turned in the above manner, more cleaning is necessary.

(4) Rotate the sleeve with the contact point of the dial indicator, contacting the bottom of the counterbore. Total indicator reading should not exceed 0.002 inch. If the total dial indicator reading exceeds the specified limit, reworking of the counterbore is necessary.

(5) The protrusion (standout) of the cylinder sleeve flange above the top flat surface of the cylinder

block is very important. The allowable standout is 0.002 to 0.005 inch. Measure cylinder sleeve standout as follows:

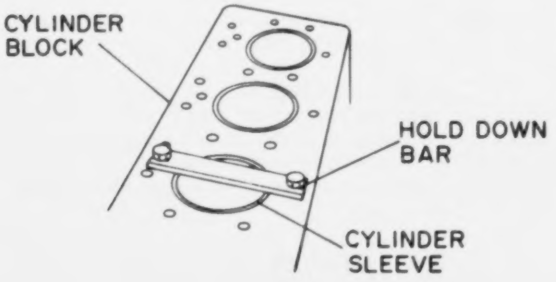
(a) Using a depth micrometer, measure depth of cylinder sleeve counterbore in the cylinder block (measure at two more locations). The depth should be 0.315 to 0.3165 inch.

(b) Using a micrometer, measure width of cylinder sleeve flange (measure at three or more locations). The width should be 0.3185 to 0.320 inch.

(c) Subtract counterbore depth from width of cylinder sleeve flange. The result is the cylinder sleeve standout. If the standout is not within 0.002 to 0.005 inch, install a cylinder sleeve shim of the proper thickness in the sleeve counterbore to bring the standout within the allowable limits. Cylinder sleeve shims are available in 0.005-, 0.010-, 0.010-, 0.015- and 0.020-inch thickness. If shimming will not correct the cylinder sleeve standout, reworking of the counterbore will be necessary.

(6) To double check the cylinder sleeve standout, insert sleeve with shims into the cylinder block. To hold flange of sleeve firmly against the counterbore seat in the cylinder block, make up a bar similar to the one illustrated in figure 14-44. Place bar across top of sleeve and secure in position with 9/16-12 capscrews and flat washers. Tighten capscrews evenly to 60 foot-pounds torque. Using a depth micrometer, measure the distance between the top of the block and top of the sleeve flange at three or more locations. Make certain the standout measurements are made from the top of the cylinder block to the top of the sleeve flange and not on the firewall.

(7) Remove sleeve.



ME 6115-545-34/14-44

Figure 14-44. Cylinder Sleeve Hold-Down Bar

c. Camshaft Bearings. Camshaft bearings must be replaced by new bearings whenever removed. Camshaft bearings should always be replaced when rebuilding engine.

### 14-87. Crankshaft, Cylinder Sleeves, and Camshaft Bearings Installation.

#### a. Cylinder Sleeve Installation.

(1) Two packing rings are used on each cylinder sleeve: one black on water side, one red on oil side.

#### CAUTION

Rubber packing rings are easily damaged. Use extreme care in handling and installing them in order not to cut or shear them. Rings swell and expand after short contact with petroleum products and certain types of permanent anti-freeze. This causes them to drop out of their cylinder sleeve grooves and their installation in the cylinder block becomes impossible. Do not pre-soak or apply lubricant to a ring.

(2) Thoroughly clean the packing ring grooves in the cylinder sleeve. Stand sleeve on a clean work bench with packing ring end up. Install black on bottom groove; install red on top groove. The rings must be installed dry without lubrication of any kind.

#### CAUTION

New cylinder sleeve packing rings must be used at each installation of a new or used sleeve. Make certain rings are not twisted.

(3) Brush a light coat of vegetable or mineral oil in lower sleeve bore in cylinder block. Be extremely careful so packing rings are not cut on sharp edges of bore in block when installing.

#### CAUTION

Do not use any other lubricant except vegetable or mineral oil; doing so prevents proper installation and operation.

(4) Install cylinder sleeve as follows:

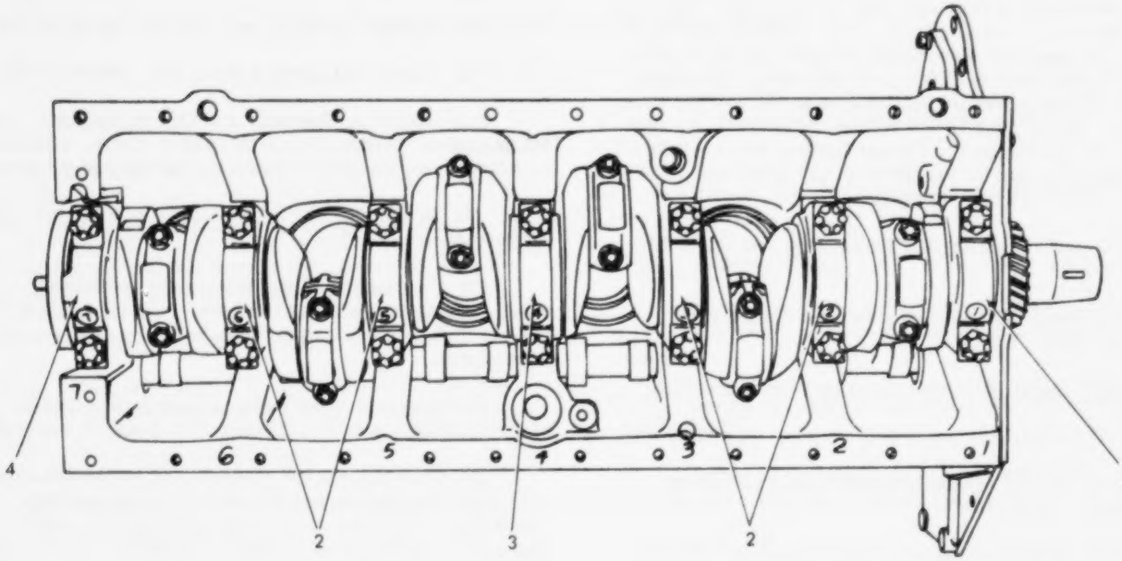
(a) Insert cylinder sleeve installer tool in cylinder block. Brush bore of tool with a light coat of vegetable or mineral oil.

(b) Position cylinder sleeve with packing rings.

(c) Carefully force the cylinder sleeve into the sleeve lower bore of the cylinder block.

#### b. Crankshaft Installation.

(1) Install the upper halves of main bearing shells in position with tang of bearing shell in slot in bearing seats of the cylinder block.



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1. Front main bearing cap
2. Intermediate main bearing caps
3. Center main bearing cap
4. Rear main bearing cap

Figure 14-45. Main Bearing Caps

CAUTION

Make certain the backs of bearing shells are free from dirt and grit particles.

(2) Lubricate all crankshaft main bearing journals with engine oil; lower the crankshaft into position in the cylinder block with flywheel flange end of crankshaft toward the rear.

CAUTION

Make certain that timing mark on crankshaft gear is aligned with timing mark on camshaft gear, when crankshaft is installed.

(3) Place the lower halves of the main bearing shells in position in the main bearing caps.

CAUTION

Make certain the backs of the bearing shells are free from dirt and grit particles.

(4) The bearing caps are numbered 1, 2, 3, etc. indicating their respective positions. Before installing center main bearing cap, insert upper thrust flanges (flanges without dowel pin holes) with oil grooves of thrust flanges located next to cheeks of the crankshaft. Position lower thrust flanges on dowel pins, with the oil grooves in the thrust flanges to the outside of the bearing cap.

(5) Install main bearing caps with numbers facing camshaft side of the engine and corresponding to number stamped on lower edge of cylinder block as shown in figure 14-45. Install the main bearing cap attaching lock bolts snugly. Force crankshaft in both directions to align the bearing caps with the upper portion of the main bearing bores.

(6) Using a torque-indicating wrench, tighten the main bearing cap lock bolts to a torque of 170 to 190 foot-pounds.

CAUTION

Do not overtighten main bearing lock bolts. If these lock bolts are overtightened, bearing caps may be distorted, causing bearing to be drawn tight against the crankshaft and premature failure will result. The crankshaft should turn freely after all capscrews are properly torqued. Never file or shim a bearing cap to make the bearings shell fit; install new bearing shells if fit on the crankshaft is unsatisfactory.

(7) Check end play of the crankshaft using a dial indicator. Tap crankshaft with a soft-headed hammer in one direction to take up slack or end play. After dial indicator is set in place, force crankshaft with a pry bar in opposite direction to obtain end play reading. The end play is 0.007 to 0.013 inch. The end play is controlled by thrust flanges at the center main bearing. If end play is not within the allowable range, replace thrust flanges. Thrust flanges are available in standard thickness (0.126 to 0.127 inch) and 0.005, 0.010, and 0.015 inch oversize.

(8) Install piston and connecting rod assembly. (para 14-83.)

(9) Install crankshaft gear and timing gear housing. (para 14-75.)

(10) Install flywheel housing. (para 14-70.)

(11) Install oil pump and oil pan. (para 14-67.)

(12) Install crankshaft pulley and vibration dampener. (para 14-63.)

(13) Refer to Operator and Organizational Maintenance Manual and install electric starter, winterization kits (if installed), manifolds, turbocharger, radiator and housing.

### c. Camshaft bearing installation.

(1) Position new bearing so that oil hole in bearing lines up with oil hole in cylinder block.

(2) Front bearing must be installed so that bearing end is flush with or below front side of cylinder block.

(3) The rear and intermediate bearings are alike. The rear bearing should be installed with the bearing end flush with the front side of the cylinder block bearing bore.

NOTE

> When a new camshaft rear bearing is installed in place, the old rear bearing will remain partly in the cylinder block. Use a punch and collapse the old bearing, preferably at the seam, and remove the old bearing with pliers.

(4) Install remaining bearings.

(5) Install cylinder sleeve. (Refer to step a. above.)

(6) Install cylinder head and valve operating mechanism. (para 14-79.)

(7) Install crankshaft. (Refer to step b. above.)

(8) Install piston and connecting rod assemblies. (para 14-83.)

(9) Install timing gears and housing. (para 14-75.)

(10) Install flywheel and housing. (para 14-70.)

(11) Install oil pump and oil pan. (para 14-65.)

(12) Refer to Operator and Organizational Maintenance Manual and install valve cover, manifolds. turbocharger, radiator, electric starter and housing.

### d. Oil Pressure Regulating Valve Installation and Adjustment.

(1) Thoroughly clean valve bore in cylinder block, lubricate valve piston with clean oil and install the regulating valve components in the reverse order of removal.

(2) Turn valve adjusting screw into cylinder block the same number of turns required for removal.

(3) With the engine re-installed in the generator set, start the engine and allow it to reach normal operating temperature. Adjust oil pressure regulating screw to obtain oil pressure of 45 psi. No further adjustment should be necessary.

### e. Oil Pressure Regulating Valve Removal.

Remove oil pressure regulating valve in the order of sequence numbers (items 31 - 36, figure 14-41, sheet 3).

(1) Thoroughly clean the area around the cylinder block where the pressure regulating valve is located.

(2) Loosen jam nut.

(3) Remove regulating valve screw, noting number of turns required for removal.

(4) Withdraw the spacer, spring and piston.

### f. Oil Pressure Regulating Valve Cleaning, Inspection and Repair.

(1) Wash valve parts in cleaning solvent and inspect carefully for wear or damage.

(2) Inspect the valve seat in the cylinder block and clean if necessary.

(3) Replace any necessary parts.

## CHAPTER 15

## BASE GROUP REPAIR INSTRUCTIONS

### 15-1. General.

a. The base group consists of a rigid frame skid base and a fuel tank. (fig. 15-1).

b. The main fuel tank is mounted in the skid base, recessed so that the engine and generator may be mounted above it without interference.

### 15-2. Disassembly.

Refer to the Operator and Organizational Maintainance Manual and remove the main fuel tank.

### 15-3. Cleaning and Inspection.

a. Clean the skid base with cleaning solvent, Federal Specification P-D-680.

b. Use a stiff bristled brush to remove heavily concentrated grease and dirt.

c. Flush inside of the fuel tank with steam under pressure. Rinse with hot water and detergent to insure that rust flakes and other foreign material have been removed.

d. Inspect the skid base, and fuel tank for cracks and distortion.

e. Inspect tapped holes for damaged threads.

### 15-4. Repair.

a. Repair cracks in the skid base, and fuel tank by welding or brazing.

b. File or sand the weld marks to an even finish.

c. Repair the threads in the tapped holes by retapping.

### 15-5. Reassembly.

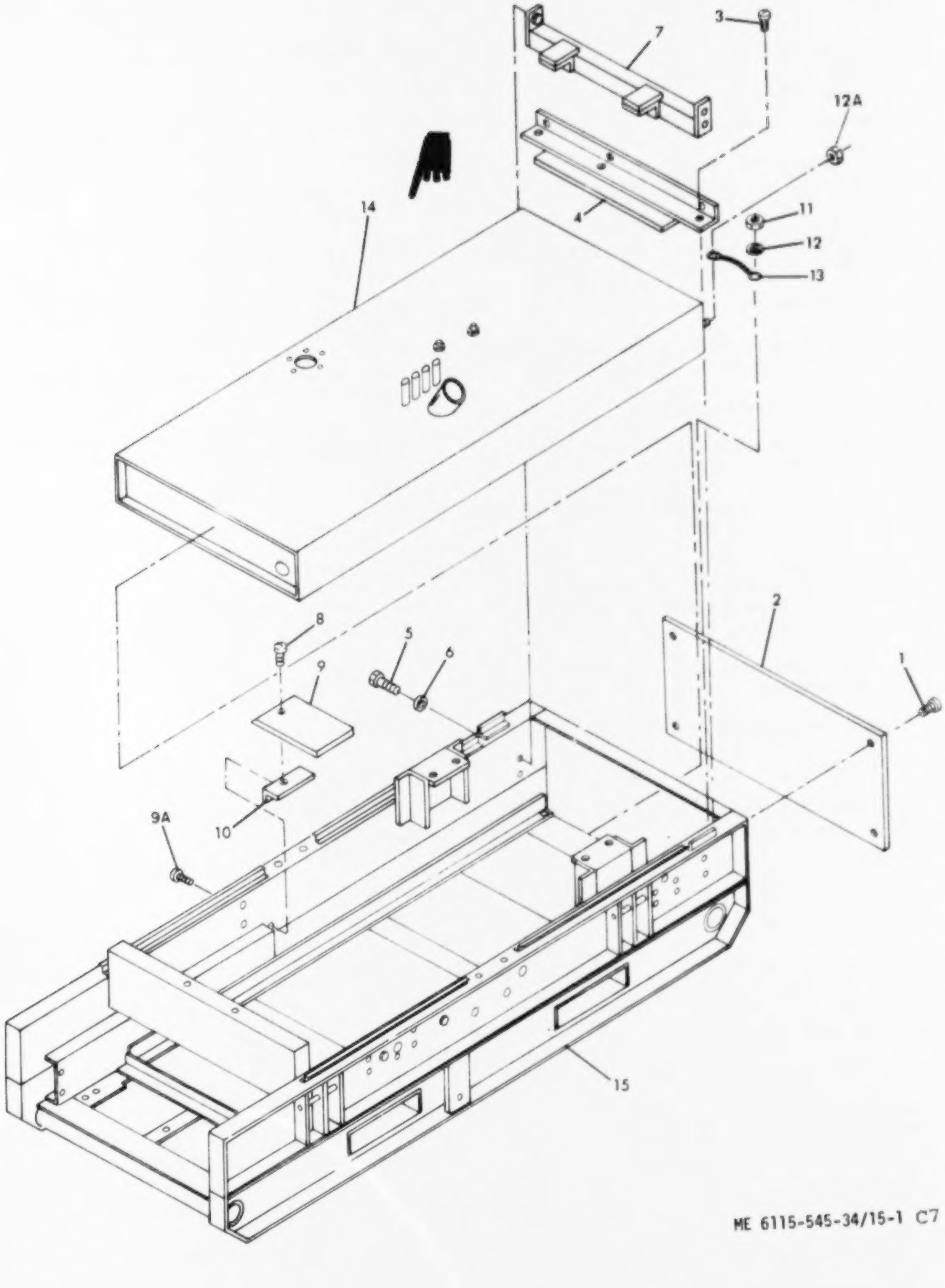
a. Install the fuel tank in the skid base. (Refer to the Operator and Organizational Maintenance Manual).

b. Install the engine and generator assembly. (Para 2-16).

c. Refer to Operator and Organizational Maintenance Manual, and install housing.

Key to Fig. 15-1

1. Screw
2. Panel
3. Screw
4. Bracket
5. Screw
6. Washer
7. Frame
8. Screw
9. Bracket
9A. Screw
10. Bracket
11. Nut
12. Washer
12A. Nut
13. Ground Strap
14. Tank
15. Base


3
7
12A
14
4
11
12
13
2
8
5
6
9
1
9A
10
15

ME 6115-545-34/15-1 C7

Figure 15-1. Base Group

# CHAPTER 15A

## PAINT AND MARKING REQUIREMENTS AFTER OVERHAUL

15 A-1. General.

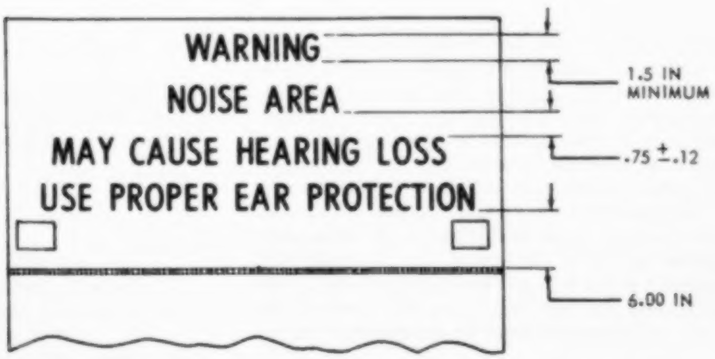
a. (AF Only) Paint and markings on the generator set shall be in accordance with AFR 35-1-3.

15 A-2. Noise Level Warning.

a. Assure that the noise level warning sign is stenciled on the top half of both rear (generator end of set) side doors as shown in Figure 15 A-1.

NOTE:

USE PAINT NSN 8010-00-297-0570 (LIQUID) OR 8010-00-844-1306 (SPRAY CAN), COLOR 33538.


WARNING
NOISE AREA
MAY CAUSE HEARING LOSS
USE PROPER EAR PROTECTION
1.5 IN MINIMUM
.75 ±.12
6.00 IN

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# CHAPTER 16

# GENERATOR SET TESTS AFTER OVERHAUL REPAIR INSTRUCTIONS

## Section I. INSPECTION

### 6-1 General.

a. A thorough inspection of the generator set shall be conducted to insure that workmanship and materials are satisfactory.

b. The inspection shall be conducted each time the generator set is overhauled or rebuilt.

### 16-2. Housing and Frame Inspection.

a. Check that lifting eyes are installed and firmly secured.

b. Check that drain holes are open to prevent moisture accumulation.

c. Insure that exposed parts are properly treated to resist corrosion.

d. Open and close panel doors, engine area doors, and generator area doors to insure proper installation and freedom of motion.

e. Inspect movable door gasketing to insure that it is weatherproof.

f. Check that all caps and covers are equipped with ties, chains, or other ties to prevent loss.

### 16-3. Engine Inspection.

a. Check mounting bolts of all components and accessories to insure that they are firmly secured.

b. Check designation and data plates for legibility.

c. Insure that fuel and hydraulic oil lines are protected from damage due to vibration.

### 16-4. Generator Inspection.

a. Insure that generator leads are properly identified and protected from damage due to vibration.

b. Insure that inspection openings are protected by screening or protective plates.

c. Check that the engine generator screws are firmly secured. See table 1-3 for proper torque values.

### 16-5. Electrical Accessories Inspection.

a. Check all cable and harness assemblies for secure fastenings and protection against chafing and vibration.

b. Insure that all cable and harness connectors are firmly secured in their proper place.

## Section II. OPERATING TESTS

### 16-6. General.

a. The tests described in this section require generator set operation and provide verification of generator set performance characteristics.

**NOTE**

> **All tests shall be conducted with the 240/416 volt connections, unless otherwise specified. All tests, that are applicable, will be conducted on both Mode I and Mode II generator sets. Mode I tests shall be conducted at 60 Hz only unless otherwise specified.**

b. Unless otherwise specified, all test instrumentation will be in accordance with Military Standardization Handbook MIL-HDBK-705 and Military Standard MIL-STD-705A.

c. Temperatures will be measured by means of appropriately located thermocouples and properly calibrated read-out devices. Thermocouples will be insulated from contact with other metals, as practical. Temperatures will be recorded in degrees Fahrenheit or Centigrade, depending on the instrument scale, but will be converted to degrees Fahrenheit in all cases. Barometric pressures will be measured by a mercurial barometer which will be corrected for the temperature of the scale, the mercury, for vapor pressure and for the location of the barometer with regard to altitude and latitude. Aneroid barometers will not be used.

d. Operational procedures required in support of the individual tests specified herein shall be performed as in the Operator and Organizational Maintenance Manual.

e. All test results, for generator set overhaul, shall be logged on the appropriate forms as required.

f. Perform the operating tests as indicated in table 16-1.

16-7. Direction of Rotation Controls.

With the generator set running at a rated load, rotate the following controls and verify their proper operation.

a. Frequency Adjust Control. On Class 1 sets clockwise rotation of the frequency adjust control rheostat must cause set frequency to increase as indicated on the frequency meter. On Class 2 sets counterclockwise rotation of manual speed control must increase frequency.

NOTE

On Class 1 sets, set manual control fuel injection pump lever in the full fuel position with the manual speed control in the IN position to assure mechanical governor does not interfere with operation of electric governor.

On Class 2 sets, set manual control fuel injection pump lever for 48 hertz operation with the manual speed control in the IN position to assure set does not operate at low speeds.

b. Voltage Adjust Control. Clockwise rotation of the voltage adjust control must cause set voltage to increase as indicated on the voltmeter.

c. Governor Paralleling Control (Class 1 sets only). Counterclockwise rotation of the governor paralleling control must cause an increase in the signal appearing at the paralleling receptacles.

d. Voltage Regulator Paralleling Control. Clockwise rotation of the voltage regulator paralleling control must cause that set to increase its share of the total reactive Kva.

16-8. Reverse Power Protective Device Test.

a. Operate two generator sets in parallel at no load, with contactors closed.

b. Lower speed of set being tested until the main contactor opens.

c. Record the value on the kilowatt meter of the other set at the moment the contactor opens. The load contactor of the set under test, must open when power flow into the generator exceeds 20 percent of the rated value.

16-9. Low Fuel Protective Device.

a. Disconnect cable to the day tank fuel solenoid valve.

b. Operate generator set at full load.

c. The low fuel protective device must operate when the fuel in the day tank falls to a point at which there is only enough to operate the set at rated load for one minute.

16-10. Parallel Operation Provisions (Real Power).

a. For Class 1 sets:

(1) Remove the shorting plug.

(2) With rated (60 kw) load on the generator set, measure the dc voltage across pins A and B of one of the paralleling receptacles (J45, J46 or J47). Adjust R28 (located in the precise relay box on Mode I sets and in the special relay box on the Mode II sets) until 7 volts dc is indicated on Mode I sets and 2.4 volts dc is indicated on Mode II sets. Insure that pin A is positive.

b. For Class 2 sets.

Adjust governor droop in accordance with paragraph 14-48 (17).

16-11. Parallel Operation Provision (Reactive Power).

a. Remove the shorting plug.

b. With rated load 60kw at .8 PF on the generator set, and the unit parallel switch in the parallel position, adjust R29 (located on the special relay box) until 7.2 volts ac is indicated across pins C and D of one of the paralleling receptacles (J45, J46 or J47).

c. Install the shorting plug.

d. With 60kw 1.0 PF load applied the change in voltage from no load should not exceed 1%. With 60kw .8 PF load applied the voltage change, from no load should be approximately 3%.

16-12. Malfunction Indicator Test.

a. The malfunction indicator system is electrically isolated and independent of the protection system. Testing of the indicators can be accomplished at the same time that the protective devices are tested in tests 6, 9, 10, 11, 12, 14, 15, 16, 17 and 18 of table 16-1.

b. In the event that one of the indicator circuits does not work, verify that the lamp is functional by operating the test and reset switch on the fault indicator panel.

16-13. Phase Balance Test Voltage.

a. General. Polyphase electrical equipment may not operate properly or may be damaged if the phase voltages of a polyphase generator differ greatly from each other. Also, large differences between the phase voltages of a polyphase generator may be an indication that the generator set has been improperly manufactured or damaged.

b. Apparatus. A frequency meter (or tachometer) as described and illustrated in MIL-HDBK-705, Method 104.1 (or 109.1) and an rms indicating ac voltmeter having an accuracy of ±0.1% of the reading shall be required to perform both procedures. A means of separately exciting the generator is required since procedure II is performed.

c. Generator with Separate Excitation.

(1) Preparation for test.

(a) Completely isolate the generator windings (armature coils and field windings).

Table 16-1. Operating Tests

| Test | MIL-STD-705 procedure | Test parameter |
|---|---|---|
| 1. Regulator and governor stability and transient response. (Short Term) | 608.1a | See tables 1-4 and 1-5. |
| 2. Overspeed protection device. | 505.2a | 2400 rpm to 2450 rpm. |
| 3. Phase balance. | 508.1c | See tables 1-4 and 1-5. |
| 4. Circuit interrupter (short circuit). | 512.1c | Instantaneously at 425 ± 25 percent of rated current. |
| 5. Circuit interrupter (overload trip). | 512.2c | 8 ± 2 minutes at 130 percent of rated current. |
| 6. Circuit interrupter (undervoltage) (Class 1 sets only). | 512.3c | Instantaneously below 48 volts. 6 ± 2 seconds at 99 ± 4 volts or less. |
| 7. Circuit interrupter (overvoltage). | 512.3c | Not more than 1 second after voltage has risen to and remained at any value greater than 153 ± 3 volts for not less than 200 milliseconds. |
| 8. Circuit interrupter (Under Frequency Trip). | 514.1 | 60 Hz = 55 ± 1<br>50 Hz = 46 ± 1<br>400 Hz = 370 ± 5 |
| 9. Low oil pressure protective device. | 515.1a | Trip pressure 20 ± 2 psi. |
| 10. Reverse power protective device. | - | Refer to para 16-8. |
| 11. High coolant temperature protective. | 515.2a | Trip temperature +222 ± 3° F. |
| 12. Low fuel protective device. | - | Refer to para 16-9. |
| 13. Regulator range. | 511.1c | Test at both 50 Hz and 60 Hz for Mode I sets. See tables 1-4 and 1-5. |
| 14. Phase sequence (rotation). | 507.1c | L1, L2, L3. |
| 15. Frequency adjustment range. | 511.2b | See tables 1-4 and 1-5. |
| 16. Parallel operation provisions. | - | Refer to para 16-10. |
| 17. Malfunction indicator system. | - | Refer to para 16-12. |
| 18. Maximum power. | 640.1b | 125 percent of rated load |

## CAUTION

Prior to performing any of the operating tests listed in table 16-1, insure that the generator set is serviced with the correct fuel, oil and coolant as listed on the data plate.

(b) Connect the frequency meter to one of the armature coils of the generator.

(c) Provide separate excitation for the exciter field.

(2) Test.

(a) Start and operate the generator at rated frequency and at no load.

(b) Adjust the excitation so that any one of the coil voltages is at rated value.

(c) Read and record the generator frequency (speed) and the voltage of each armature coil.

d. Generator with separate excitation:

(1) Determine from the data obtained in 16-13d.(2) the maximum and minimum armature coil voltages.

(2) The voltage unbalance is the difference between the maximum and minimum armature coil voltages. To express this in percent divide this difference by rated armature coil voltage and multiply by 100.

Voltage Unbalance (Coil), in percent =

$$\frac{V\ \text{max} - V\ \text{min}}{V\ \text{Rated}} \times 100$$

(3) Compare the results of step (2) above with the requirements.

### 16-14. Regulator Range Test.

a. General. The voltage adjust device associated with the voltage regulator provided with the generator set must have adjustment capable of varying the regulated voltage throughout the limits and under the various load conditions and temperature ranges without causing the voltage droop of the set to exceed specification limits. The voltage adjust device also must be capable in some cases of providing an operating voltage other than rated voltage for special types of equipment and to compensate for external line drop.

b. Apparatus. Instrumentation for measuring load conditions, ambient temperature, and the generator field (or exciter field) voltage and current shall be as described and illustrated in MIL-HDBK-705.

c. Preparation for Test.

(1) Preparation for test.

(a) Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, Paragraph 205.1.10 for one voltage and frequency.

(2) Test.

(a) Start and operate the generator set and allow the set to stabilize at rated load, rated voltage and rated frequency. During this period record all instrument readings including thermal instrumentation at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made. Adjustments to load, voltage or frequency controls shall be recorded on the data sheet at the time of adjustment. Stabilization shall be considered to have occurred when four consecutive voltage and current readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

(b) No further adjustments shall be made to any set control for the remainder of this test except the control panel voltage adjust device.

(c) Record all instrument readings.

(d) Remove load.

(e) Record all instrument readings (after transients have subsided).

(f) Adjust the terminal voltage to the maximum specified value.

(g) Record all instrument readings.

NOTE

At voltages above rated values, the generator will be supplying less than rated current; and at voltages below rated values, the generator will be supplying greater than rated current. Caution should be taken to avoid damage to instrumentation and load banks.

(h) Apply rated load (rated kw at rated power factor).

(i) Record all instrument readings (after transients have subsided).

(j) Remove load and adjust voltage to the maximum attainable value or to a value just prior to actuation of the overvoltage protection device.

NOTE

The output voltage may exceed the rating of connected equipment.

(k) Record all instrument readings (after transients have subsided).

(l) Apply rated load.

(m) Record all instrument readings (after transients have subsided).

(n) Adjust voltage to the minimum specified value at rated load.

(o) Record all instrument readings (after transients have subsided).

(p) Remove load.

(q) Record all instrument readings (after transients have subsided).

(r) Adjust voltage to the minimum attainable value or a value just prior to activation of the under-voltage protection device.

(s) Record all instrument readings (after transients have subsided).

(t) Repeat steps (a) through (s) above for all other voltage connection(s).

d. Sample Calculations. Regulation (droop) is defined for the purposes of this method as the no-load value minus the rated load value divided by the rated load value the quantity expressed in percent.

% Regulation =

$$\frac{\text{(No-Load Voltage)} - \text{(Rated-Load Voltage)}}{\text{(Rated-Load Voltage)}} \times 100$$

e. Results. The data sheets shall indicate the voltage regulation as a percent of rated voltage within the specified limits at the minimum and maximum specified voltages and the regulation as a percent of rated voltage at the extremes, the maximum and minimum voltages attainable and the actuation of the protection devices (if applicable). Compare these results with the requirements of Table 16-1.

### 16-15. Frequency and Voltage Regulation, Stability and Transient Response Test (Short-Term).

a. General. The frequency regulation (sometimes referred to as droop) of a generator set is the maximum difference between the no load value of frequency and the value at any load up to and including rated load. This difference is expressed as a percentage of the rated frequency of the generator set. The voltage regulation is expressed similarly except that the rms value of voltage is used.

Frequency stability describes the tendency of the frequency to remain at a constant value. Generally, the instantaneous value of frequency is not constant but varies randomly above and below a mean value. Stability may be described as either short-term or long-term depending upon the length of time that the frequency is observed. Another term, bandwidth, describes the limits of these variations. Bandwidth is expressed as a percentage of the rated frequency of the generator set. Voltage stability is described similarly.

Frequency transient response describes the reaction of the frequency to a sudden change in some condition; such as, a load change on a generator set. This response consists of the amount of excursion beyond the mean of the new operating band, and the recovery time. The recovery time is the interval beginning at the point where the frequency leaves the original prescribed operating band and ending at the point where it enters and remains within the new prescribed operating band. The amount of surge is expressed as a percentage of the rated frequency of the generator set. The recovery time is expressed in seconds. The voltage transient response is described similarly.

b. Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705. In addition, recording meter(s) for recording voltage and frequency shall be required. The recording meters shall be as described in Table 2-1.

c. Procedure.

(1) Preparation for test.

(a) Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, paragraphs 205.1.10, for one voltage and frequency. Connect the signal input of the recording meter(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing input to the voltage regulator. (Power the recording meter(s) from the commercial utility.)

(b) Set the recording meter chart speed(s) to a minimum of 6 inches per hour. The following items shall be recorded on both the data sheets and recording chart(s):

1. The date
2. The serial number(s) of the recording meter(s)
3. Generator set identification
4. The recording chart speed(s)
5. The data reading number

(c) Place all instrumentation referred to in paragraph 16-15b. in operation.

(2) Test.

(a) Start and operate the generator set and allow the set to stabilize at rated load, rated voltage and rated frequency. During this period operate the recording meter(s) at a chart speed of not less than 6 inches per hour, and record all instrument readings including thermal instrumentation at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made. Adjustments to load, voltage or frequency controls shall be recorded on both the data sheet and the recording chart(s) at the time of a adjustment. Stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or frequency has been made.

(b) After stabilization has occurred, drop the load to no load and reapply rated load a number of times (three should be sufficient) to assure that the no load and rated load voltage and frequency values are repeatable and that the frequency and voltage regulation is within the limits specified in the procurement document. If any adjustments are necessary, paragraph (a) above must be repeated. Reapply rated load.

(c) The recording meter chart speed(s) shall be 12 inches per minute throughout the remainder of this test. At each of the following load conditions (one step) operate the set for a minimum of 40 seconds (or the short-term stability period plus the allowable recovery time as specified in the procurement document). During each load condition read and record all instrument readings except thermal instrumentation (for three-phase sets it is not necessary to record line-to-line voltages). Each load condition shall be applied to the generator set in one step at the end of the short-term stability period for the previous load condition. The load conditions are:

1. Rated load
2. No load
3. Rated load
4. No load
5. Rated load
6. No load
7. Rated load
8. No load
9. 3/4 rated load
10. No load
11. 3/4 rated load
12. No load
13. 3/4 rated load
14. No load
15. 1/2 rated load
16. No load
17. 1/2 rated load
18. No load
19. 1/2 rated load
20. No load
21. 1/4 rated load
22. No load
23. 1/4 rated load
24. No load
25. 1/4 rated load
26. No load
27. Rated load
28. No load
29. Rated load
30. No load
31. Rated load
32. No load

(d) Repeat (a) through (c) for all voltage connection(s) and frequency(ies).

d. Results.

(1) Prepare a chart giving for each load change the momentary overshoot or undershoot and the recovery time. For each constant load, give the maximum voltage variation.

(2) Referring to figure 16-1, begin by determining the observed (B) and steady-state (D) voltage bandwidths.

(a) Mark numerically the stabilizations occurring after each load change, starting with the stabilization obtained before the first load change.

(b) Determine the observed voltage bandwidth (B) by marking the maximum trace excursion and minimum trace excursion in the stabilized portion. Draw two lines parallel to the axis of chart movement, one each passing through these maximum and minimum trace excursions respectively.

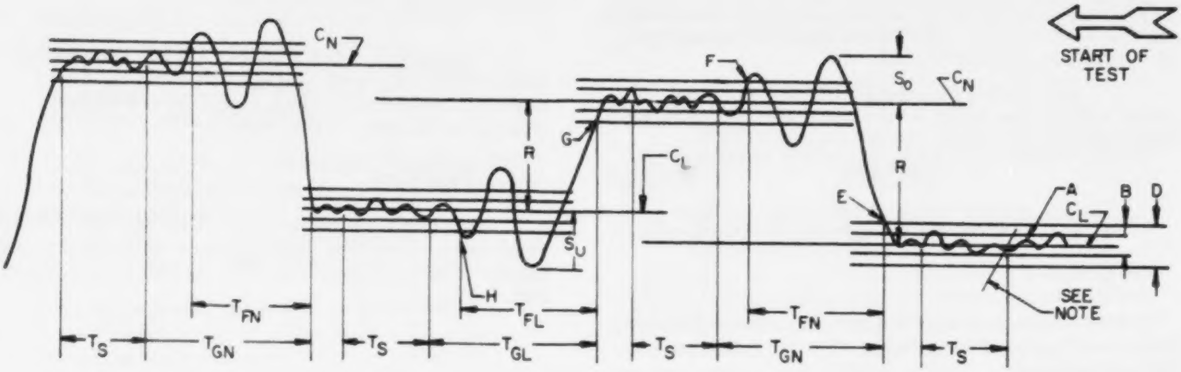
(c) Draw a line (C) parallel to and equidistant from the edges of the observed voltage bandwidth. Determined in (b) above.

(d) Using the rated voltage of the generator and given requirements of table 16-1, calculate the steady-state voltage bandwidth (D). Draw this steady-state voltage bandwidth as two parallel lines, parallel to and equidistant from the median (C) at the observed voltage bandwidth.

(3) To determine the maximum voltage variation at constant load:

(a) One-half the observed voltage bandwidth (B) is the plus or minus value of voltage deviation at constant load.

(b) Divide each of the values obtained in (a)



Trace and definitions apply to either voltage or frequency.

NOTE

Chart marked at start of test.

| | |
|---|---|
| A | Actual instrument trace of function. |
| B | Observed steady-state band (two lines parallel to the axis of chart movement, one each passing through the center points of maximum and minimum trace excursion respectively during the short-term stability sample period, $T_S$). |
| C | Mean of observed band. |
| $C_L$ | Mean value at selected load. |
| $C_N$ | Mean value at no load. |
| D | Prescribed steady-state band. |
| E | Point at which trace initially leaves prescribed load band under condition of decrease in load. |
| F | Point at which trace enters and remains within prescribed no load band. |
| G | Point at which trace initially leaves prescribed no load band. |
| H | Point at which trace enters and remains within prescribed load band. |
| R | Regulation between any two loads. |
| S | Surge after a load change. |
| $S_O$ | Overshoot |
| $S_U$ | Undershoot |
| $T_{FL}$ | Observed recovery time, no load to load. |
| $T_{FN}$ | Observed recovery time, load to no load. |
| $T_G$ | Maximum allowable recovery time. |
| $T_{GL}$ | Maximum allowable recovery time, no load to load. |
| $T_{GN}$ | Maximum allowable recovery time, load to no load |
| $T_S$ | Prescribed short-term sample time for determining stability. |

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Figure 16-1. Overshoot and Undershoot Chart Recording

by the rated voltage of the generator and multiply by 100 to convert to percentage.

(4) To determine the maximum overshoot and undershoot at each load step, and express this as a percentage of its rated voltage, proceed as follows:

(a) From the meter recording charts, determine the maximum amount that the voltage trace goes beyond the line (3) of the observed voltage band following the load change. See figure 16-1 for illustration of overshoot and undershoot.

(b) Divide the result obtained in (a) by rated voltage (as given on the generator nameplate), then multiply by 100 to convert to percentage.

CAUTION

Do not use the constant operating voltage at each load as the divisor in the computation. Use only the rated voltage of the generator.

(5) To determine the time required to restore stable voltage conditions after each load change (recovery time):

(a) The prescribed steady state voltage bandwidth, extended to the point at which the voltage trace leaves the prescribed steady state band, shall be considered as the time at which the transient conditions begin. The point at which the voltage trace enters and remains within the prescribed band after a load change shall be considered as the point at which stabilization begins.

(b) Measure the distance (in inches) on the chart from the point where the voltage trace leaves the prescribed steady state band to the point where it re-enters and remains within the prescribed voltage band for the next load condition.

(c) Divide this distance by the chart speed (in inches per second). This will give the voltage recovery time, in seconds.

(6) Determine the voltage regulation for all load changes (e.g. rated load to no load, 1/2 rated load to no load to 1/4 load, etc.) as follows:

(a) Using the indicating voltmeter readings subtract the load value of voltage from the no load value for each load change (e.g. step (a) to step (b)). (For voltage regulators utilizing single-phase voltage sensing, the value of voltage in the sensed phase only shall be used in the above calculations. For voltage regulators utilizing multi-phase voltage sensing the average value of the sensed voltage shall be used.)

(b) Convert each of the values obtained in (a) above to a percentage of rated voltage by dividing by the rated voltage and multiplying by 100. This is the voltage regulation expressed in percent.

(c) Repeat paragraph 16-15d. (1) above substituting frequency for voltage.

(d) Compare the results tabulated in paragraphs 16-15d. (1) and 16-15d. (6)(c) with the requirements of Table 16-1.

### 16-16. Frequency Adjustment Range Test.

a. General. It is necessary that the frequency of a generator set be adjustable to provide rated frequency at various load conditions as required in certain applications and to synchronize two or more generator sets for parallel operation.

b. Apparatus. Instrumentation for measuring load conditions, field voltage and current, and ambient temperature shall be as described and illustrated in MIL-HDBK-705.

c. Procedure.

(1) Preparation for test. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, paragraph 205.1.10.

(2) Test.

(a) Start and operate the generator set and allow it to stabilize at rated load, rated voltage and rated frequency.

During this period, readings of the load and field instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. However, adjustments available to the operator, specifically adjustments to voltage and frequency adjust devices. Adjustments to the load, voltage or frequency shall be noted on the stabilization data sheet. Stabilization will be considered to have occurred when four consecutive voltage and current readings of the exciter field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last load, voltage or frequency adjustment has been made.

(b) No further adjustments shall be made to any set control for the remainder of this test except for the control panel frequency adjust device.

(c) For each of the conditions in the following steps allow approximately 2 minutes between eac adjustment and the subsequent instrument readings.

(d) Adjust the generator set frequency for the specified maximum frequency at rated load. Read and record all instrument readings.

(e) Adjust the generator set frequency for the specified minimum frequency at rated load. Read and record all instrument readings.

(f) Reduce the load to zero.

(g) Adjust the generator set frequency for the maximum attainable frequency. Read and record all instrument readings. If the overfrequency or overspeed protection device actuates, read and record all instrument readings just prior to the point of actuation and note on the data sheet that the protection device actuated.

**NOTE**

> This step is not applicable to generator sets having governors that utilize a threaded shaft and lock nut(s) or other mechanical means as a method of operator speed adjustment.

(h) Adjust the generator set frequency for the minimum attainable frequency. Read and record all instrument readings.

**NOTE**

> This step is not applicable to generator sets having governors that utilize a threaded shaft and lock nut(s) or other mechanical means as a method of operator speed adjustment.

(i) Repeat 16-16c.(1) and 16-16c.(2)(a) through (f) for each frequency.

d. Results. The data sheet shall show the maximum and minimum frequencies attained at rated load, the maximum and minimum attainable frequencies at no load and actuation of the protection devices (if applicable). Compare these results with the requirements of Table 16-1.

### 16-17. Overspeed Protective Device Test.

a. General. To assure that adequate protection is afforded the generator set against overspeeding, the overspeed protective device must operate properly.

b. Apparatus. A frequency meter or tachometer as described and illustrated in MIL-HDBK-705, Methods 104.1 or 109.1 shall be required.

c. Procedure.

(1) Preparation for test. Connect the frequency meter in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, Paragraph 205.1.9, or utilize the tachometer in accordance with the manufacturer's instructions. Electronic governor and throttle stops must be deactivated.

(2) Test.

(a) Start and operate the generator set at rated speed (frequency), rated voltage and no load.

(b) Slowly increase the engine speed until the overspeed protective device actuates. Record the speed of the generator set at this point, and the malfunction indicator light indication.

**CAUTION**

> Do not operate the set in excess of 125 percent of rated speed or as otherwise limited in the procurement document.

(c) Attempt to start the set. Record if starting is achieved. If the set did not start, reset the overspeed protective device.

(d) Repeat steps (a) through (c) above two additional times.

d. Compare the test results with requirement of Table 16-1.

### 16-18. Circuit Interrupter Test (Short Circuit).

a. General. A circuit interrupter is connected between the generator voltage reconnection system and the generator set output terminals to disconnect the generator output from the load and also to protect the generator from a short circuit. The circuit interrupter is operated from a current sensor external to the interrupter.

b. Apparatus. Instrumentation for measuring load conditions shall be as described and illustrated in MIL-HDBK-705. In addition, a non-inductive shunt, as short-circuiting switch, galvanometer matching networks, an oscillograph as described and illustrated in MIL-HDBK-705, Method 106.1, paragraph 106.1.3 and galvanometers having a flat frequency response (flat within plus or minus five percent) from DC to 3,000 hertz will be required.

c. Procedure.

(1) Preparation for test.

(a) Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, paragraph 205.1.10 for one voltage and frequency.

(b) Connect the shunt, galvanometer matching network, oscillograph, and short-circuiting switch as illustrated in figure 512.1.I.

(2) Test.

(a) Start and operate the generator set at rated voltage, rated frequency and rated load.

(b) Set the oscillograph time marker to a minimum of 0.01 seconds or use a 60 hertz timing trace set the chart speed such that the individual peaks of the current waveform are clearly visible and adjust the peak-to-peak rated current amplitude to a minimum of 0.5 inch (or approximately 12 millimeters).

(c) Prior to closing the short-circuiting switch, record a portion of the steady state load for calibration. With the same load conditions record all instrument readings.

(d) With oscillograph still recording the steady state current, close the short-circuiting switch.

CAUTION

> If the circuit interrupter fails to operate within the specified time, remove the short circuit to prevent damage. Note the failure to operate on the data sheet.

(e) The generator set contains a short-circuit malfunction indicator, check and record its indication.

(f) Repeat steps (a) thru (e) above for each possible short circuit condition ($L_1$-$L_0$, $L_2$-$L_3$, $L_1$-$L_2$-$L_3$ etc.)

(g) Repeat steps (a) thru (f) above for both voltage connections if applicable.

d. Results.

(1) From the oscillograms taken in 16-18c (2)(d), determine the time between the indicated closure of the short-circuiting switch and the opening of the circuit interrupter. See figure 512. 1-II.

(2) Calculate the short-circuit current using the peak-to-peak amplitudes of the current trace and the steady state ammeter reading prior to application of the short circuit. See figure 512. 1-II.

(3) Tabulate the above results and the malfunction indicator indication for each line connection at each voltage connection and compare the results with the requirement in table 16-1.

### 16-19. Circuit Interrupter Test (Overload Current)

a. General. A circuit interrupter is connected between the generator voltage reconnection system and the generator output terminals to disconnect the generator output from the load and to protect the generator from a sustained overload current. The circuit interrupter is operated from a current sensor external to the interrupter.

b. Apparatus. Instrumentation for measuring load conditions and field voltage and current shall be as described and illustrated in MIL-HDBK-705. In addition a stopwatch or an oscillograph with galvanometer matching network and a non-inductive shunt as described and illustrated in MIL-HDBK-705, Method 106. 1, paragraph 106. 1. 3 and galvanometers having a flat frequency respond (within plus or minus 5%) from dc to 3000 Hz.

c. Procedure.

(1) Preparation for test. Connect the load and field instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205. 1, paragraph 205. 1. 10 for one voltage and frequency.

CAUTION

> If the circuit interrupter fails to operate within the time specified in table 16-1 at any time during the performance of this method, manually open the circuit interrupter and reduce the load impendance to rated value before reclosing the circuit interrupter. Record on the data sheet the failure of the interrupter to operate and the total elapsed time the overload was on the set.

(a) Start and operate the generator set at rated voltage, rated frequency and rated load.

(b) Allow the generator set to stabilize at rated load, voltage and frequency. During this period, readings of the load and field instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and frequency. Adjustment to the load, voltage or frequency shall be noted on the data sheet. Stabilization will be considered to have occured when four consecutive voltage and current readings of the exciter field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last load, voltage or frequency adjustment has been made.

(c) In one step, increase the load current to the overload current value specified in table 16-1 (the increase in current may be accomplished by any practical means, e.g. reactively or using reduced voltage levels).

NOTE

> The frequency shall be maintained at rated conditions, the load current shall be kept constant and the load current shall be balanced equally among the phases. Simultaneously with the load current increase, start the stopwatch.

(d) Record all load instrumentation and the time, in seconds, required for the circuit interrupter to operate.

(e) The generator set contains an overload malfunction indicator, check and record its indication.

(f) Allow the generator set to cool at rated load for a minimum of 15 minutes.

(g) Repeat steps (c) thru (f) except that the load current is increased to the overload current value in Phase A only. Phases B and C remain at the rated load current value.

(h) Repeat step (g) except that the load is increased to the overload current value in phase B only. Phases A and C remain at the rated load value of current.

(i) Repeat step (g) except that the load is increased to the overload current value in phase C only. Phases A and B remain at the rated load value of current.

d. Results. The data sheets shall show, as a minimum, whether or not the circuit interrupter operated, the time(s) required for the interrupter to operate, the indication of the malfunction indicator, the overload load condition(s) and the stabilization data. Compare the time(s) requirements of table 16-1.

16-20. Circuit Interrupter Test (Overvoltage and Undervoltage)

a. General. To protect the load from generator malfunction (e.g. overvoltage or undervoltage) a circuit interrupter is connected between the generator voltage reconnection system and the generator output terminals. A voltage sensing circuit operates the circuit interrupter if an overvoltage or undervoltage condition occurs and thus protects the load from a generator malfunction.

b. Apparatus. Instrumentation for measuring voltage and frequency shall be as described and illustrated in MIL-HDBK-705. Resistor(s), galvanometer matching networks, an oscillogram (as described and illustrated in MIL-HDBK-705, Method 106.1, paragraph 106.1.3) and galvanometers having a minimum flat frequency response (flat within plus or minus 5 percent) from DC to 3,000 Hertz and the voltage divider transformer network will be required.

c. Procedure I. (Overvoltage)

(1) Preparation for test.

(a) Locate and disconnect the input circuit to the input terminals of the overvoltage protective sensing circuit and connect the apparatus as illustrated in figure 512.3-I for one voltage connection.

(b) Connect the frequency meter to the output terminals of the generator set.

(2) Test.

(a) Start and operate the set at rated frequency and no load.

(b) Close the switch (see figure 512.3-I) and use resistance, R1 to adjust the voltage to the overvoltage value specified in table 16-1. The set has provisions for shutdown upon an overvoltage condition, it will be necessary to temporarily deactivate this provision to permit adjustment of the overvoltage value. This may be done by activation of the "protective bypass" (Battle Short) switch. Do not deactivate the circuit interrupter trip circuitry.

(c) Open the switch, reset the overvoltage circuit and adjust the resistance, R2, until Voltmeter Number 2 reads rated voltage.

(d) Repeat (b) and (c) to assure that the specified overvoltage and rated voltage settings are correct.

(e) Set the oscillograph chart speed such that the individual waveform peaks are clearly visible. Set the timing lines to a minimum of 0.01 seconds per line or use a 60 Hertz time trace. Adjust the trace peak-to-peak amplitude to a minimum of one inch (or 25 millimeters).

(f) Read and record both voltmeter readings.

(g) With the oscillograph recording and the circuit interrupter closed, close the switch. (See figure 512.3-I).

(h) Reactivate the shutdown provision if used.

(i) The generator set contains an overvoltage malfunction indicator, check and record its indication.

(j) Record whether or not the set shuts down.

(k) Open the switch, reset the overvoltage circuit if necessary, restart the set if required, and close the circuit interrupter.

(l) Repeat steps (e) thru (k) above two additional times.

d. Procedure II. (Undervoltage)

(1) Preparation for test.

(a) Locate the input terminals of the undervoltage sensing circuit and connect the apparatus as illustrated in figure 512.3-I.

(b) Repeat step (b) of para. 16-20c. (1)(b).

(2) Test.

(a) Start and operate the set at rated frequency and no load.

(b) Close the switch (see figure 512.3-I) and use the resistance, R1, to adjust the voltage to the rated value.

(c) Open the switch and adjust the resistance, R2 until Voltmeter Number 2 reads the undervoltage value specified in Table 16-1. This test shall be repeated for each undervoltage value.

(d) Repeat steps (b) and (c) above to assure that the specified undervoltage and rated voltage settings are correct.

(e) Set the oscillograph chart speed such that the individual waveform peaks are clearly visible. Set the timing lines to a minimum of 0.01 seconds per line or use a 60 Hertz timing trace. With the switch open, adjust the trace peak-to-peak amplitude to a minimum of one inch (or 25 millimeters).

(f) With the set operating and the circuit interrupter and the switch open, read and record both voltmeter readings.

(g) Close the switch and circuit interrupter.

(h) With the oscillograph recording, open the switch.

(i) After allowing sufficient time for the circuit interrupter to operate, check and record the indication of the undervoltage malfunction indicator.

(j) Close the switch, and close the circuit interrupter.

(k) Repeat steps (e) thru (j) above two additional times.

(l) Repeat (a) thru (k) for the other undervoltage value specified in para. 16-1.

e. Results.

(1) From the oscillograms made in 16-20c determine and tabulate the time between the application of the overvoltage and operation of the circuit interrupter for each application of overvoltage.

(2) From the oscillograms made in 16-20d determine and tabulate the time between the application of the undervoltage and the operation of the circuit interrupter for each application of undervoltage.

(3) Compare these results with the requirements of table 16-1.

### 16-21. Low Oil Pressure Protective Device Test.

a. General. Since generator sets frequently operate unattended for long periods, the engine is equipped with a low oil pressure protective device. This device shuts down the engine when the oil pressure drops below the safe limit.

b. Apparatus. The following equipment shall be required to perform this test.

Oil pressure gage (±1%)
Flexible oil line (or copper tubing)
Regulating valves
Brass fittings.

c. Procedure.

(1) Preparation for test. With the set not operating remove the protective device tap from the engine block and reconnect as shown in figure 515.1-I with the protective device and oil pressure gage in approximately the same horizontal plane as the protective device tap located on the engine.

(2) Test.

(a) With the bleeder valve closed and the shut-off valve in the oil pressure line open, start and operate the set at rated speed (use the set instrumentation) and at no load.

(b) Open the bleeder valve slightly to purge air from the system.

(c) Close the bleeder valve and record the oil pressure as indicated on the external gage.

(d) Almost completely close the shut-off valve.

(e) Slowly open the bleeder valve until the low oil pressure protective device shuts down the engine. Record the reading of the oil pressure gage at the point of set shutdown (see figure 515.1-II).

(f) Record operation of the malfunction indicator light.

d. Results. Compare the value of shutdown pressure with the requirement of Table 16-1.

### 16-22. Overtemperature Protective Device Test.

a. General. The overtemperature device must be capable of protecting the engine in the set against overheating for any reason.

b. Apparatus. Instrumentation for measuring load conditions and set and ambient temperatures shall be as described and illustrated in MIL-HDBK-705, Method 205.1, Paragraph 205.1.10.

c. Procedure.

(1) Preparation for test.

(a) Connect the load instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, Paragraph 205.1.10.

(b) Install a thermocouple to measure the same temperature as seen by the protective device sensor.

(2) Test.

(a) Start and operate the generator set at rated voltage, rated frequency (speed), and rated load.

(b) Block the cooling air to the generator set by any suitable means.

(c) Continuously monitor the temperature seen by the thermocouple installed in paragraph 16-22 c(1)(b) above. Record the temperature at which the overtemperature protective device actuates. Record the temperature at which the coolant temperature indicator illuminates.

CAUTION

If the engine fails to shutdown when the temperature exceeds the maximum trip value specified in Table 16-1, the test shall be immediately discontinued.

d. Results. Compare the results with the requirement of Table 16-1.

### 16-23. Phase Sequence Test (Rotation)

a. General. Unless the phase sequence (rotation) of the load terminals of a three-phase generator set is correct, serious damage or injury could be done to connected equipment and to personnel as a result of reversed motor rotation or excessive current surges.

b. Apparatus. A phase sequence (rotation) indicator as described and illustrated in MIL-HDBK-705, Method 116.1 or a three-phase motor whose direction of operation in relation to phase sequence is known shall be required.

c. Procedure.

(1) Connect the generator set load terminals to the applicable test applicable test apparatus for one of the set three-phase voltage connections. Recheck the connections to insure that $L_1$, $L_2$ and $L_3$ of the generator set are connected to $L_1$, $L_2$ and $L_3$ of the test apparatus respectively.

(2) Start and operate the generator set at rated voltage and frequency. The set indicating instruments shall be sufficient indication of output voltage and frequency.

(3) Close the circuit interrupter and determine the direction of phase sequence (rotation) by observing the indicator, or by noting the direction of rotation if a three-phase motor is used. Record results.

(4) Check the phase sequence (rotation) of the power output of each power receptacle on the generator set by connecting the applicable test apparatus to the receptacle and repeating steps (1) thru (3) above.

(5) Repeat steps (a) thru (d) above for all other three-phase voltage output connections of the generator set.

d. Results. The phase sequence (rotation) as indicated by the test shall be checked against the requirements of Table 16-1.

### 16-24. Maximum Power Test.

a. General. The maximum power of a generator set is a function of the ambient conditions (temperature and altitude) and the mechanical condition of the engine at any particular time.

b. Apparatus. Instrumentation for measuring load conditions, field voltage and current, pressures and temperatures shall be as described and illustrated in MIL-HDBK-705.

c. Procedure.

CAUTION

This procedure subjects the generator set to a severe overload which may be damaging if maintained for too long a period of time.

(1) Preparation for test.

(a) Connect the load and instrumentation in accordance with the applicable figure of MIL-HDBK-705, Method 205.1, paragraph 205.1.10 for one voltage and frequency.

(b) Install appropriate thermocouples to measure the following temperatures:

1. Engine coolant (engine outlet and inlet)
2. Exhaust gas(es) (the exhaust manifold(s shall be drilled and tapped as close as possible to the combustion chamber(s).
3. Lubricating oil sump.
4. Engine combustion air in (located at the inlet of the intake manifold).

(c) Install appropriate pressure instrumentation to measure the following items:

1. Exhaust pressure (combined exhaust gases in exhaust manifold).
2. Intake air manifold pressure (between air filters and manifold).

(d) Obtain and record the barometric and water vapor pressures (see MIL-HDBK-705, Method 220.2).

(e) Bypass the set circuit interrupter.

(f) Connect the set to a source of fuel containing a specified fuel required by the procurement document.

(2) Test.

(a) Start and operate the generator set and allow it to stabilize at rated load, rated voltage and rated frequency (speed). During this period, readings of all instruments including thermal instrumentation shall be recorded at minimum intervals of 10 minutes. If necessary, adjustments to the load, voltage and rated frequency. However, adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage or frequency adjust devices. On generator sets utilizing a droop-type speed control system as the prime speed control, the speed and droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made. Adjustments to the load, voltage or frequency controls shall be recorded on both the data sheet and recording chart(s). Stabilization will be considered to have occurred when four consecutive voltage and current recordings of the exciter field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage or frequency has been made.

(b) Perform this test using resistive load only. Remove reactive load after stabilization.

(c) For sets with droop-type governors:

1. Load the set to 125% of rated load. Adjust the frequency to the rated value and maintain the load for 5 minutes.

(d) For generator sets with isochronous-type governors, repeat step (c) above but do not adjust the frequency.

(e) Results. Compare these results with the requirement of Table 16-1.

16-25. Under Frequency Protective Device Test.

a. General. For generators that power certain types of equipment, it is extremely important that the circuit interrupter open when the frequency fails appreciably below rated value. Severe damage may otherwise result to the powered equipment. To insure that the circuit interrupter will open at or before the critical frequency value, the generators are equipped with an underfrequency protective device. The device on this generator operates electrically. Although the under frequency protective device must be capable of functioning at any voltage throughout the specified voltage operating range, it is necessary only to perform the test at the specified maximum, at rated, and at minimum voltage limits.

b. Apparatus. Instrumentation for measuring load conditions shall be as described and illustrated in method 205.1, paragraph 205.1.10 of MIL-HDBK-705.

c. Procedure.

(1) Preparation For Test. Connect a voltmeter and frequency meter to the generator set terminals, ahead of the circuit interrupter, and the remainder of the apparatus as shown in the applicable figure of paragraph 205.1.10 of MIL-HDBK-705.

(2) Test.

(a) Operate the generator at rated speed and voltage, and at no load since the generator is equipped with an electrical-type underfrequency protective device, this test shall be repeated with the voltage adjusted to maximum and minimum voltage for the specified voltage operating range.

(b) With the circuit interrupter closed, slowly decrease the operating speed until the protective device causes the circuit interrupter to open. The electric governor must be deactivated to sufficiently decrease the speed on Class 1, precise sets.

(c) Record the speed.

(d) Repeat the test while rapidly decreasing the operating speed. Again record the speed.

(e) Operate the generator at rated speed and voltage, and at rated load.

(f) Repeat steps (b), (c) and (d).

d. Results. Compare the test value of frequency with that given in Table 16-1.

# CHAPTER 17

# KIT AND OPTIONAL EQUIPMENT REPAIR INSTRUCTIONS

## Section I. FUEL BURNING WINTERIZATION KIT

### -1. Introduction.

This chapter contains intermediate (field) (direct and general support) and depot repair instructions for the kits and optional equipment of the generator sets.

### 17-2. General.

The fuel burning winterization kit is available as an aid in starting the generator set in temperatures from -25° F to -65° F. The kit consists of a heater, which burns fuel from the engine fuel supply, a control panel, and the necessary plumbing which will route coolant through the heater and to the oil pan heat exchanger and engine water jacket through an outlet at the front of the cylinder block and back to the heater. A thermostat on the engine cylinder head starts and stops the heater according to coolant temperature when the system is operating.

### 17-3. Troubleshooting.

Troubleshoot the fuel-burning winterization kit using table 17-1. Typical malfunctions, the possible causes and the necessary corrective actions are tabulated.

### 7-4. Removal and Disassembly.

a. Removal. Refer to Operator and Organizational Maintenance Manual and remove fuel-burning winterization kit.

b. Disassembly.

(1) See figure 17-1 and disassemble the fuel-burning heater. Disconnect and tag leads sequentially during disassembly procedure.

(2) See figure 17-2 and disassemble the fuel-burning heater control box. Disconnect and tag leads sequentially during disassembly procedure.

### 17-5. Fuel Burning Heater Control Box Testing, Repair and Replacement.

a. Test of Circuit Breaker.

(1) Disconnect connector.

(2) Using an ohmmeter with the R x 1 scale selected, read across the circuit breaker. With the rcuit breaker in the closed position (ON) the reading ould be zero (0) ohm.

(3) Open the circuit breaker (OFF), select the R x 100 scale, the meter should indicate infinity ohms.

(4) Connect the circuit breaker between a 8 Vdc source and a resistive load, such that the current draw from the source is 16.73 amperes. The circuit breaker should not trip. If the circuit breaker trips, replace the circuit breaker.

b. Test of Power Switch.

(1) Disconnect connector.

(2) Using an ohmmeter set scale to R1. Check for continuity between terminals 4 to 6 and 1 to 3 in the ON position. If defective, replace.

c. Replacement of Light Assembly.

(1) Disconnect connector J26.

(2) Disconnect and tag leads sequentially.

(3) Remove lens cap and locking bolt. Remove light assembly from rear of panel.

(4) Replace in reverse order.

d. Replacement of Circuit Breaker.

(1) Disconnect connector J26.

(2) Disconnect and tag leads.

(3) Unscrew holding nut and lock washer. Remove circuit breaker from rear of panel.

(4) Replace in reverse order noting the proper placement of locating lug.

e. Replacement of Power Switch.

(1) Disconnect connector J26.

(2) Disconnect and tag leads sequentially.

(3) Remove mounting hardware and extract the switch through the rear of the panel.

(4) Replace in reverse order noting that ON is to be in the up position.

### 17-6. Cleaning.

a. Clean all metal parts with cleaning solvent Federal Spec P-D-680 and dry thoroughly.

b. Clean electric motor, micro-switch, limit switch, thermostat, preheater elements and all electrical connectors and wiring with a cloth moistened with cleaning solvent Federal Spec P-D-680. Do not submerge electrical components in cleaning solvent.

c. Clean all orifices, sintered filter and screen to make sure they are free from any obstruction.

Table 17-1. Fuel-Burning Winterization Kit Troubleshooting Chart

| Malfunction | Probable cause | Corrective action |
|---|---|---|
| 1. Press-to-test lamp does not go on. | a. Faulty circuit breaker. | a. Replace circuit breaker. (para 17-5.) |
| | b. Open circuit. | b. Isolate and repair. |
| 2. Turn switch on, nothing happens. | a. Faulty circuit breaker open. | a. Replace circuit breaker. (para 17-5.) |
| | b. Open circuit. | b. Isolate and repair. |
| 3. Switch on, will not ignite. Blower operates. | a. Burned out igniter. Orifice clogged. | a. Visually inspect and test. Clean orifice (para (17-7.) |
| | b. Pressure regulator solenoid closed. | b. Check regulator valve. (para 17-7.) |
| | c. Fuel pump. | c. Check pump separately. |
| 4. Fan runs all the time with switch off. | a. Broken quartz rod. | a. Replace rod. |
| | b. Flame switch out of adjustment. | b. Readjust. |
| | c. Wiring connections incorrect. | c. Correct connections. |
| 5. Heater starts, then goes out. | a. Faulty micro-switch. | a. Replace switch. (para 17-5.) |
| | b. Overheats, trips limit switch. | b. Check fuel rate (too high). Check for closed ducts or restrictions. Check blower speed. |
| 6. Circuit breaker pops open. | Short circuit. | Disconnect basic components, one at a time, to isolate short - then check wiring. Replace shorted/defective components or wire. |
| 7. Failure to shut off. | a. Fuel regulator valve stuck open. | a. Replace valve. |
| | b. Flame switch stuck open. | b. Adjust or replace. |
| 8. Surging combustion. | a. Fuel regulator operating erratically. | a. Check fuel rate and replace valve if necessary. |
| | b. Fuel pump operating erratically. | b. Replace pump. |
| 9. Coolant pump fails to recirculate liquid. | Faulty coolant pump. (See malfunction no. 4 of table 17-3) | Repair or replace pump. (See malfunction no. 4 of table 17-3.) |
| 10. Coolant pump turns over but fails to deliver fluid. | Pump passages or blade slots plugged with foreign matter. | Remove pump from motor; disassemble and clean. Clean filter. |
| 11. Erratic or reduced output. | a. Air leak. | a. Check tubing connections for leaks. |
| | b. Reduced voltage. | b. Check voltage input to motor. |

Table 17-1. Fuel-Burning Winterization Kit Troubleshooting Chart (Cont)

| Malfunction | Probable cause | Corrective action |
|---|---|---|
| 11. (Continued) | c. Motor lag, low rpm | c. Check motor brushes for excessive wear. |
| | d. Scored cam ring bore. | d. Replace the cam ring. |
| | e. Foreign matter in pump blade slots. | e. Remove pump from motor; disassemble and clean pump and filter. |
| 12. Leakage. | a. Face of seal cage scored, or damaged seal "0" ring. | a. Disassemble and inspect seal cage face and "0" ring. Refinish or replace as required. |
| | b. Seal face of adapter scored. | b. Disassemble and inspect seal surface. Refinish or replace the adapter. |
| 13. Motor failure. | a. Worn brushes. | a. Remove and replace. |
| | b. Worn bearings. | b. Replace motor. |
| | c. Burned armature. | c. Replace motor. |

17-7. Heater Assembly and Component Inspection.

a. Inspect regulator valve leaks or damaged threads. Check resistance of solenoid coil. Resistance must be 150 ohms.

(1) Inspect nozzle orifice for damaged threads and obstruction at pin holes. Pin hole diameter is 0.012 inch.

(2) Inspect sintered filter for clogged or damaged condition.

b. Flame Switch and Quartz Rod Inspection.

(1) Inspect flame switch for distorted or broken springs, loose flame pivot points or stripped threads and cracked or damaged insulation. Check flame switch for continuity.

(2) Inspect quartz rod for damage or burned condition.

c. Inspect pump and motor assembly for damaged threads and other damage.

(1) Pump inspection.

(a) Inspect adapter for damaged or scored face, warped condition, damaged seal face and for motor shaft bore wear. Face of adapter must be parallel within 0.001 inch. Adapter bore diameter must be 0.315 to 0.318 inch. Adapter face must be parallel with rotor side of adapter within 0.001 inch per inch.

(b) Inspect rotor and rotor blades for excessive wear. See table 17-2 and inspect rotor and blades for proper dimensions.

(c) Inspect seal cage for scored or damaged face. Remove all imperfections by lapping, or replace seal cage.

(d) Inspect cam ring and port plate for damaged, scored, or warped position.

(2) Motor assembly inspection.

(a) Inspect fan for damaged blades, cracks, and breaks.

(b) Inspect motor for damaged receptacle and worn brushes.

d. Inspect burner chamber for defective threads, or burned or damaged condition.

e. Inspect heat exchanger for damage or warpage.

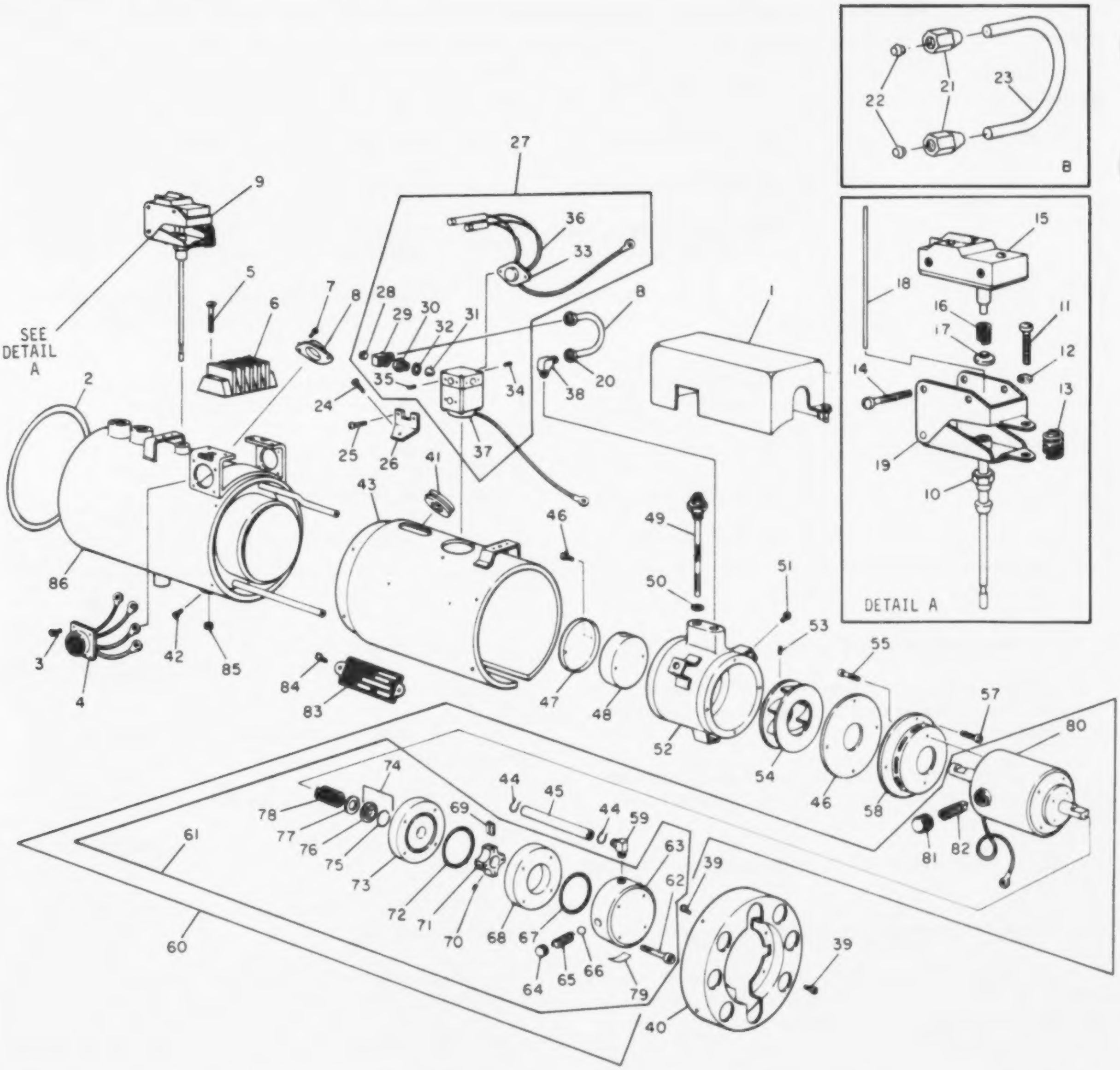
17-8. Repair.

a. Replace all gaskets, seal rings, motor brushes and ceramic vaporizer at each overhaul.

b. Seal faces of adapter and seal cage can be dressed to remove minor nicks, scratches or scoring. Remove only material necessary to clean seal face.

c. Replace all parts that do not pass inspections in paragraph 17-7 above and all electrical components that do not pass electrical tests as outlined in test procedure, paragraph 17-11 which follows.

(1) Replacement of terminal board and limit switch.



SEE DETAIL A
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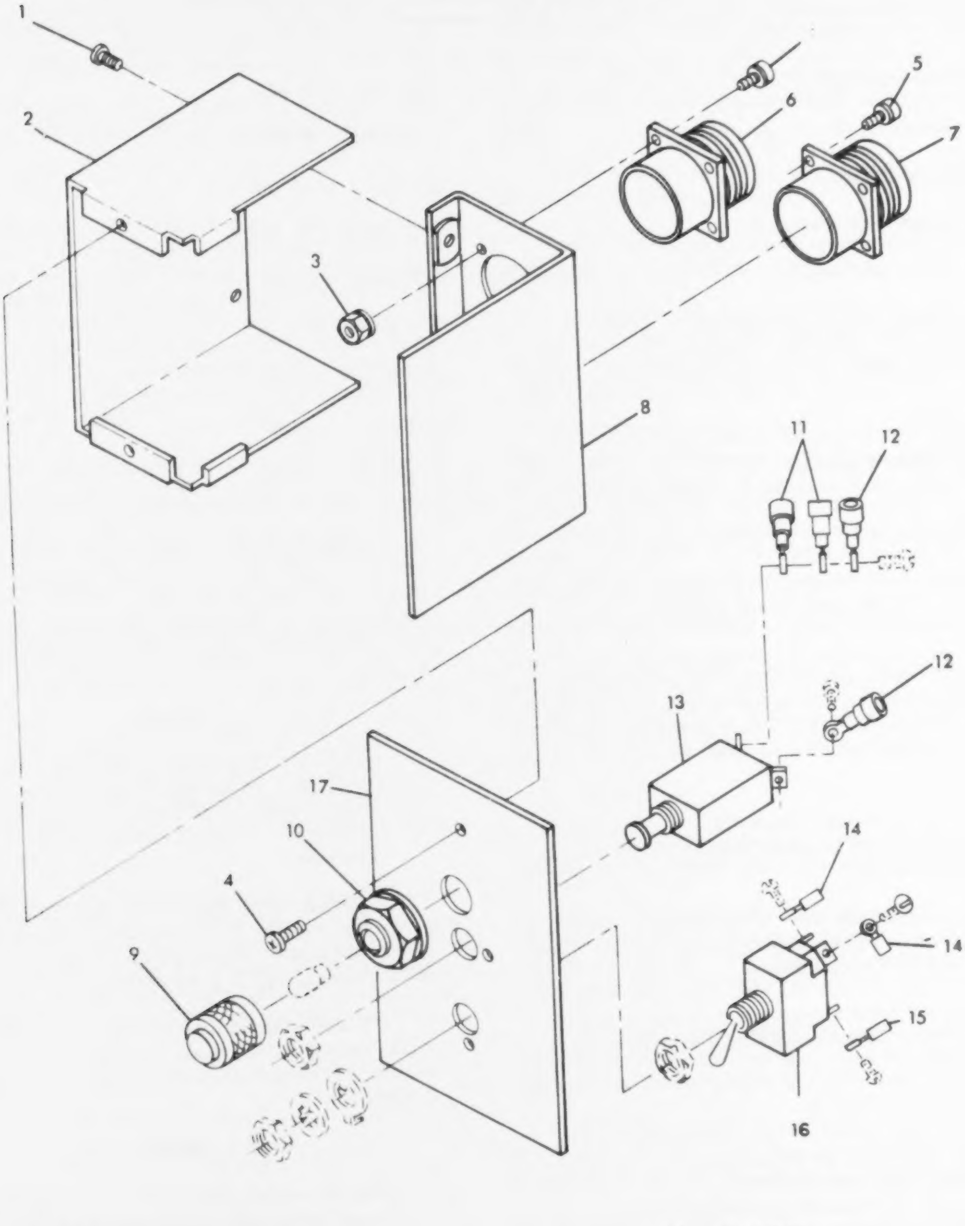
1. Cover
2. Strap
3. Screw
4. Connector
5. Screw
6. Terminal
7. Screw
8. Switch
9. Switch assy
10. Nut
11. Screw
12. Washer
13. Spring
14. Screw
15. Switch
16. Spring
17. Retainer
18. Rod
19. Frame
20. Tube assy
21. Nut
22. Sleeve
23. Tube
24. Screw
25. Screw
26. Bracket
27. Valve assy
28. Plug
29. Orifice
30. Body
31. Filter
32. Gasket
33. Screw
34. Setscrew
35. Setscrew
36. Pre-heater
37. Valve
38. Elbow
39. Screw
40. Cover
41. Grommet
42. Screw
43. Housing
44. Clamp
45. Hose
46. Screw
47. Retainer
48. Vaporizer
49. Igniter
50. Gasket
51. Screw
52. Burner
53. Setscrew
54. Fan
55. Screw
56. Plate
57. Screw
58. Inlet
59. Elbow
60. Motor-pump assy
61. Pump assy
62. Screw
63. Plate
64. Plug
65. Spring
66. Ball
67. Packing
68. Ring
69. Blade
70. Setscrew
71. Rotor
72. Packing
73. Adapter
74. Seal assy
75. Packing
76. Retainer
77. Washer
78. Spring
79. Decal
80. Motor
81. Cap
82. Brush
83. Plate
84. Screw
85. Plug
86. Heat exchanger

ME 6115-545-34/17-1

Figure 17-1. Fuel Burning Engine Coolant Heater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1. Screw
2. Frame
3. Nut
4. Screw
5. Screw
6. Connector
7. Connector
8. Cover
9. Lens
10. Indicator
11. Terminal
12. Terminal
13. Circuit breaker
14. Terminal
15. Terminal
16. Switch
17. Plate

ME 6115-545-34/17-2

Figure 17-2. Fuel Burning Heater Control Box

Table 17-2. Fuel Burning Winterization Coolant Pump Wear Limits

| Item | Dimensional limits (inches) |
|---|---|
| Rotor head diameter | 0.904 - 0.906 |
| Rotor head length | 0.246 - 0.248 |
| Rotor bore diameter | 0.3033 - 0.3038 |
| Rotor blade slot width | 0.0935 - 0.0945 |
| Rotor blade slot depth | 0.263 - 0.268 |
| Blade height | 0.247 - 0.249 |
| Blade thickness | 0.091 - 0.093 |
| Blade width | 0.247 - 0.249 |
| Adapter bore diameter | 0.315 - 0.318 |

17-9. Reassembly.

a. Reassemble control box, heater, and kit as illustrated in figures 17-1 and 17-2.

b. Exercise care in replacing quartz rod as it is easily broken if dropped. After installation, gently move rod up and down to make sure it moves freely in its stainless steel tube. Also make sure at least 1/32 inch extends out of tube when rod is resting on bottom.

c. Assemble motor assembly, combustion air inlet, inlet plate and combustion fan, before installing burner assembly.

d. Make sure lead wire from motor assembly is on side of blower opposite name plate before drawing it through casing grommet.

e. Make sure all wire leads are connected to their respective terminals as tagged during disassembly.

NOTE

Coolant pump cannot be assembled completely and installed as a separate unit. It must be assembled as it is installed on short shaft end of motor.

f. Install seal spring and seal washer over end of motor shaft. Place performed packing in seal cage, then install seal cage over end of motor shaft with seal face facing forward.

g. Install pump adapter over motor shaft and align holes with tapped holes in motor.

h. Install pump rotor on motor shaft and temporarily tighten rotor set screw. Place preformed packing in groove of pump adapter. Place cam ring in position aligning scribe mark. With motor shaft end play taken up in direction of pump, make certain there is at least 0.002-inch clearance between outer face of rotor. Move rotor back and forth as necessary to produce this clearance, then tighten set screw.

NOTE

Make sure that adapter and cam ring are tightly compressed together when determining 0.002 inch clearance, otherwise, a false reading will be obtained.

i. Install rotor blades in rotor slots making sure that grooves in blades face away from direction of rotation. Pump rotates counterclockwise when viewing end of port plate.

j. Place preformed packing in groove of port plate, then position plate against cam ring. Align scribe marks and secure with four hex socket head screws.

NOTE

Plug threaded ports with caps if pump is not to be assembled in heater immediately.

k. Replace all defective wiring in control box and heater assembly. Remove wire tags.

l. Wiring harness repair and rebuild. Refer to Chapter 5.

17-10. Adjustments.

a. Coolant Pump Relief Valve. The coolant pump relief valve is a non-adjustable relief valve. The valve is set to relieve pressure at 30 to 35 psi. To assure proper functioning of this valve, spring must measure 1.164 inches free length and have a 0.750-inch working length with a load of 1 pound, plus or minus 0.1 pound, applied. If spring fails to meet these requirements, replace spring.

b. Fuel Regulator Valve. Remove cover plate and disconnect fuel tube assembly at orifice assembly.

### 17-11. Testing.

a. Regulator Valve. Connect a fuel supply (3 to 15 psi) and 24 Vdc to regulator. Regulator valve should operate and produce a steady stream of 21 to 23 cubic centimeters of fuel per minute (at 70° F). If fuel rate is not within these tolerances, adjust regulator valve by turning the adjusting screw clockwise to increase flow rate or counterclockwise to decrease flow rate. This test can be made using a graduated container and stop watch.

b. Igniter. With igniter removed from heater, ground igniter and supply 24 Vdc power to igniter terminal. Igniter should draw approximately 10.5 amperes and heat to a bright red color in a few seconds.

c. Flame Switch.

(1) Test flame switch using an ohmmeter to check continuity of microswitch. Depress microswitch button. This will be the ignition or start position of switch.

(2) Continuity should be made between two NO (normally open) terminals and also between each of NO terminals and common terminals. There should e an open circuit between two NC (normally closed) erminals and also between common terminals and two NC terminals.

(3) Release microswitch button. This will be run position of microswitch. Continuity should be made between two NC terminals and common terminals. There should be no continuity made between the NO ignition or start terminals, or NO terminals and common terminals. Replace microswitch if it does not check out correctly.

NOTE

The common terminal is connected to blower motor which operates at all times when heater is in operation.

d. Coolant Pump and Motor Assembly.

(1) After coolant pump has been overhauled, it must be tested before being reinstalled on heater.

(2) Mount motor and pump assembly on a test stand and install proper fittings in inlet and outlet ports. Attach hose line from supply tank to port marked IN.

(3) Attach discharge line with pressure gauge and needle valve to port marked OUT and return to supply tank.

(4) Attach electrical plug to motor receptacle and plug in to dc power supply.

(5) Turn power switch on and run unit for approximately 15 minutes on 24 Vdc.

(6) Close valve in outlet line. (make sure discharge pressure does not exceed a maximum of 30 to 50 psi when closing this valve). Open and close valve a few times to check consistency of valve performance.

(7) To check pump for rated flow and pressure, adjust valve in discharge line until a reading of 2 psi is obtained on pressure gauge. Using a suitable timer, check for rated coolant flow of 80 gph (gallons per hour) minimum at 2 psi discharge pressure (at 70° F.) Amperage draw must not exceed 6 amperes during this test. Observe smoothness of operation of both pump and motor. Seal leakage of 1 cc per hour is maximum when pump is operating at 2 psi discharge.

(8) Turn power supply off, then remove discharge line and fitting from OUT port. Plug this port and apply 40 psi hydrostatic pressure for 20 minutes to inlet port. No leakage shall be evident during this test.

e. Motor.

(1) The blower motor, (without coolant pump attached) can be tested when installed in heater.

(2) Check end play on motor shaft, grasp short end and rotate in either direction at the same time moving in and out. The end play should not exceed 0.010 to 0.025 inch, and fan should rotate freely.

(3) Use a strobe light to check motor rpm's (blower installed on heater). The fan speed should be approximately 8500 rpm when 24 Vdc is applied.

(4) The blower motor should not draw more than 6 amperes (at 70° F). Higher amperage will indicate a defective motor. Replace defective motor.

### 17-12. Installation.

Refer to Operator and Organizational Maintenance Manual and install fuel-burning heater kit.

## Section II. ELECTRIC WINTERIZATION KIT

### 17-13. General.

The electric winterization kit is available as an aid in starting the generator set in temperatures from 25° F to -65° F. The electrical winterization kit consists of a heat exchanger, control box, coolant pump, thermostat and accessories. The primary purpose of the kit is to maintain the set in a heated condition, at any ambient temperature from 125° F to -65° F to enable it to accept 75% of rated load in one step within 20 seconds after starting action is initiated. The coolant temperature is thermostatically controlled at 130° F to 150° F.

The kit can also be used to warm the Generator Set for initial starting within 5 hours at any ambient temperature down to -65° F.

Power for operation of the kit may be obtained from any power source that supplies 205 to 240 volts at 50, 60 or 400 Hz single phase. For electrical winterization kit operating instructions refer to Fig. 2-11.

### 17-14. Troubleshooting.

Troubleshoot the electric winterization kit using table 17-3. Typical malfunctions, the possible causes, and the necessary corrective action are tabulated.

### 17-15. Removal and Disassembly.

a. Removal. Refer to Operator and Organizational Maintenance Manual and remove electric winterization kit.

b. Disassembly.

(1) Refer to Operator and Organizational Maintenance Manual and disassemble the electric winterization kit.

(2) See figure 17-3 and disassemble the coolant pump.

(3) See figure 17-4 and disassemble the electric winterization control box as follows:

(a) Remove screws (1) and cover (2).

(b) Tag all leads attached to heat sink (14) and (15).

(c) Remove nut (5) and screw (6) and remove leads.

(d) Remove (7) thru (15) in sequential order.

(e) Tag and unsolder leads from semiconductors (12) and (13), bracket (16) and grommet (17) can then be removed.

(f) Remove items (18) thru (39) in sequential order.

### 17-16. Inspection and Repair.

a. Replace all gaskets, seal rings and motor brushes at each overhaul.

b. Replace all electrical and mechanical parts that do not meet the requirements specified herein and in table 17-4.

### 17-17. Reassembly.

Reassemble control box and coolant pump and motor assembly in the reverse order of the numerical sequence in figure 17-4 and figure 17-3.

### 17-18. Testing.

a. Coolant Pump and Motor Assembly Test.

(1) After coolant pump has been reassembled, it must be tested before being reinstalled.

(2) Mount motor and pump assembly on a test stand and install proper fittings in inlet and outlet ports. Attach hose line from supply tank to port marked IN.

(3) Attach discharge line with pressure gauge and needle valve to port marked OUT and return to supply tank.

(4) Attach electrical plug to motor receptacle and plug in to dc power supply.

(5) Turn power switch on and run unit for approximately 15 minutes on 24 Vdc.

(6) Close valve in outlet line. (Make sure discharge pressure does not exceed a maximum of 30 to 40 psi when closing this valve). Open and close valve a few times to check consistency of relief valve performance.

(7) To check pump for rated flow and pressure, adjust valve in discharge line until a reading of 2 psi is obtained on pressure gauge. Using a suitable timer, check for rated coolant flow of 80 gph (gallons per hour) minimum at 2 psi discharge pressure (at 68°F.) Amperage draw must not exceed 3.3 amperes during this test. The drive motor speed should be approximately 7500 rpm. Observe smoothness of operation of both pump and motor. Seal leakage of 1 cc per hour is maximum when pump is operating at 2 psi discharge.

(8) Turn power supply off, then remove discharge line and fitting from OUT port. Plug this port and apply 40 psi hydrostatic pressure for 20 minutes to inlet port. No leakage shall be evident during this test.

b. Electric Winterization Control Box Components.

(1) Transformer. Inspect the transformer for visual damage to lugs, windings, etc. If visual damage is obvious, replace transformer. Open transformer primary and secondary windings and check the winding resistances. The primary resistance (terminals 1 and 2) shall be 6.77 ohms ± 10 percent. The secondary (terminals 3 and 5) shall be 0.108 ohm ± 10 percent. Apply 230 Vac at 60 Hz winding 1-2 with the secondary open circuit. The exciting current shall be less than 0.04 amperes, rms. Apply 253 Vac to 1-2. The exciting current shall be less than 0.065 amperes, rms. With the secondary open circuit, apply 230 Vac to winding 1-2. The voltage across 3 to 4 and 4 to 5 shall be 14.8 volts rms, ± 1 percent. If any of the above tests are failed, replace the transformer.

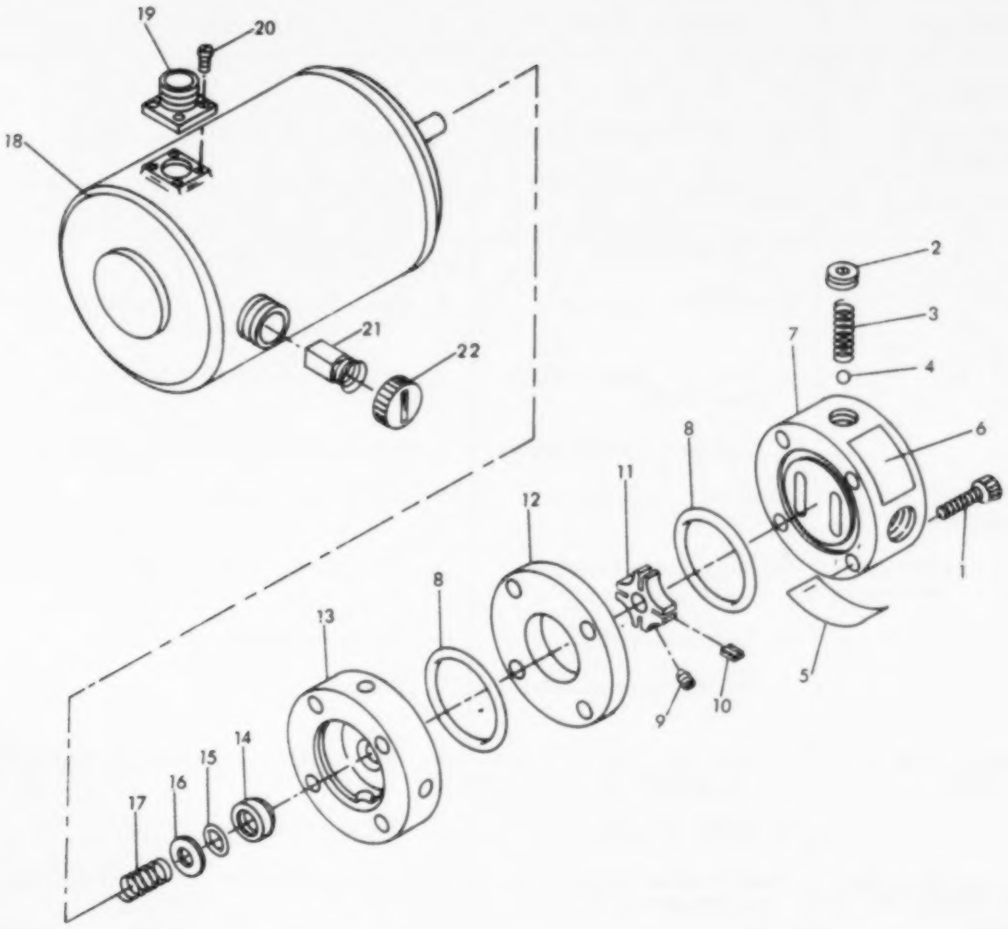
(2) Inspect the control relay for visual damage. If visual damage is obvious, replace relay. Check relay coil with an ohmmeter. The coil resistance should be 300 ohms ± 10 percent at, or corrected to, 25° C. Apply 24 Vdc to the coil with a dc power supply. The two normally open contacts shall close. Remove the 24 Vdc; the two contacts shall open. If defective, replace per paragraph 17-15.

(3) Test the four control box diodes per paragraph 14-10. Replace a defective diode.

(4) Replace defective connectors.

Table 17-3. Electric Winterization Kit Troubleshooting Chart

| Malfunction | Probable cause | Corrective action |
|---|---|---|
| With S301 closed: | | |
| 1. DS302 does not illuminate. | a. Defective wiring. | a. Repair or replace broken wiring. |
| | b. Defective switch S301. | b. Check switch for continuity across contacts. |
| | c. Defective circuit breaker CB301. | c. Check circuit breaker for correct operation with an ohmmeter. |
| | d. Defective indicator. | d. Check indicator for continuity; it should have some resistance. |
| | e. Defective diodes CR301 to CR304. | e. Check diodes with ohmmeter. |
| | f. Defective transformer. | f. Refer to transformer test, paragraph 17-18. |
| 2. DS301 does not illuminate. | Same as a. to f. above. | Same as a. to f. above. |
| 3. HTR1 and HTR2 do not heat up. | a. Relay K301 does not energize. | a. Test relay. Refer to paragraph 17-18. |
| | b. Defective wiring. | b. Repair or replace wiring. |
| | c. Heating element defective. | c. Replace. |
| 4. Coolant pump does not operate. | a. Same as a, b, c, e, and f in step 1 above. | a. Same as a, b, c, e, and f in step 1 above. |
| | b. Defective pump. | b. Replace pump. |
| 5. Coolant pump fails to recirculate liquid. | Faulty coolant pump. (See malfunction no. 4) | Repair or replace pump. (See malfunction no. 4) |
| 6. Coolant pump turns over but fails to deliver fluid. | Pump passages or blade slots plugged with foreign matter. | Remove pump from motor; disassemble and clean. Clean filter. |
| 7. Erratic or reduced output. | a. Air leak. | a. Check tubing connections for leaks. |
| | b. Reduced voltage. | b. Check voltage input to motor. |
| | c. Motor lag, low rpm | c. Check motor brushes for excessive wear. |
| | d. Scored cam ring bore. | d. Replace the cam ring. |
| | e. Foreign matter in pump blade slots. | e. Remove pump from motor; disassemble and clean pump and filter. |
| 8. Leakage. | a. Face of seal cage scored, or damaged seal "O" ring. | a. Disassemble and inspect seal cage face and "O" ring. Refinish or replace as required. |
| | b. Seal face of adapter scored. | b. Disassemble and inspect seal surface. Refinish or replace the adapter. |
| 9. Motor failure. | a. Worn bearings. | a. Replace motor. |
| | b. Burned armature. | b. Replace motor. |



1. Screw
2. Plug
3. Spring
4. Ball
5. Nameplate
6. Decal
7. Plate
8. Packing
9. Set screw
10. Blade
11. Rotor
12. Ring
13. Adapter
14. Seal
15. Packing
16. Washer
17. Spring
18. Motor assy
19. Connector
20. Screw
21. Spring brush
22. Brush cap

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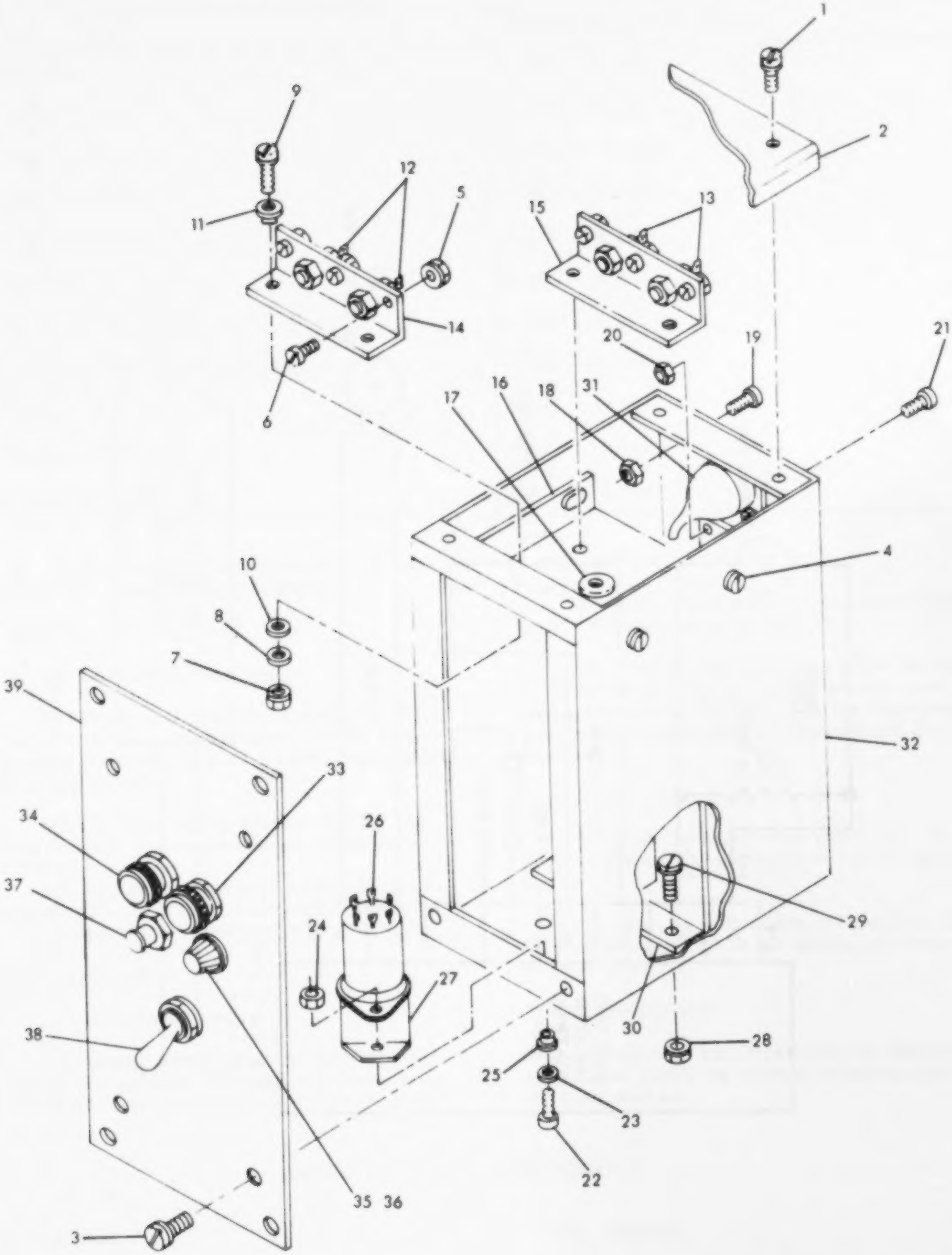
Figure 17-3. Electric Winterization Pump

KEY to fig. 17-4.

1. **Screw**
2. **Cover**
3. **Screw**
4. **Screw**
5. **Nut**
6. **Screw**
7. **Nut**
8. **Washer**
9. **Screw**
10. **Washer**
11. **Washer**
12. **Semiconductor**
13. **Semiconductor**
14. **Heatsink**
15. **Heatsink**
16. **Bracket**
17. **Grommet**
18. **Nut**
19. **Screw**
20. **Nut**
21. **Screw**
22. **Screw**
23. **Washer**
24. **Nut**
25. **Washer shoulder**
26. **Relay**
27. **Insulator pad**
28. **Nut**
29. **Screw**
30. **Transformer**
31. **Wiring harness assy**
32. **Chassis**
33. **Light assy**
34. **Light assy**
35. **Fuse**
36. **Fuseholder**
37. **Circuit breaker**
38. **Switch**
39. **Panel**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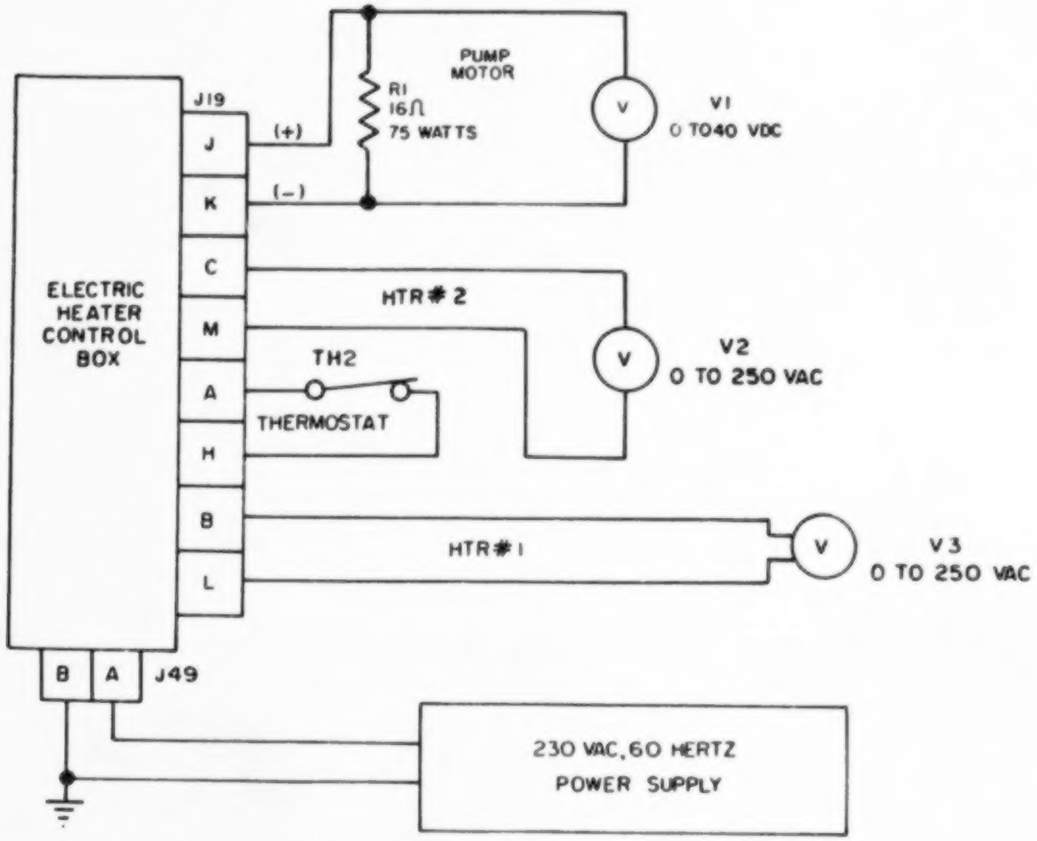
ME 6115-545-34/17-4

Figure 17-4. Electric Heater Control Box Assembly


PUMP MOTOR
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J
K
(+)
(−)
R1
16Ω
75 WATTS
V
V1
0 TO40 VDC
ELECTRIC HEATER CONTROL BOX
C
M
A
H
B
L
HTR# 2
TH2
THERMOSTAT
V
V2
0 TO 250 VAC
HTR# 1
V
V3
0 TO 250 VAC
B
A
J49
230 VAC, 60 HERTZ
POWER SUPPLY

ME 6115-545-34/17-5

Figure 17-5. Electric Winterization Kit Heater Control Box Test Set-Up

Table 17-4. Electric Winterization Coolant Pump Wear Limits

| Item | Dimensional Limits (inches) |
|---|---|
| Rotor diameter | 0.904 - 0.906 |
| Rotor width | 0.246 - 0.248 |
| Rotor bore diameter | 0.3033 - 0.3038 |
| Rotor blade slot width | 0.0935 - 0.0945 |
| Rotor blade slot depth | 0.262 - 0.268 |
| Cam ring width | 0.249 - 0.250 |
| Cam ring bore diameter | 1.000 - 1.002 |
| Blade thickness | 0.091 - 0.093 |
| Blade width | 0.247 - 0.249 |
| Blade height | 0.247 - 0.249 |
| Adapter bore diameter | 0.315 - 0.318 |

(5) Wiring harness inspection replacement, repair and fabrication (Refer to Chapter 5).

(6) Circuit breaker test.

(a) Disconnect connector.

(b) Using an ohmmeter, set scale to R1 and read across the circuit breaker. With the circuit breaker in the closed position (ON), the reading should be zero(0) ohm.

(c) Open the circuit breaker (OFF), set the scale to R100, the reading should be infinity.

(d) Connect to a circuit which will drive 23.0 amps at 28 Vdc. Circuit breaker should not trip. If it trips, replace per paragraph 17-5.

(7) Power switch set.

(a) Disconnect connector.

(b) Using an ohmmeter set the scale to R1. Check for continuity between terminals, 1-2, 5-6, 3-4 and 7-8 in the ON position. If defective, replace per paragraph 17-5.

(8) Fuse holder and light assembly replacement. Replace per paragraph 17-5.

(9) Test the control box as shown in figure 17-5 and table 17-5. If control box fails test, check wiring. (Problem must be in wiring since the components have been qualified in paragraph 17-18b(1) thru (8)).

c. Heater Test.

(1) With the control box energized, check for 230 Vac across the terminals on heaters number 1 and 2.

(2) With the control box deenergized, check for continuity in each of the heating elements. Replace if defective.

### 17-19. Installation.

Refer to Operator and Organizational Maintenance Manual and install the electric winterization kit in the generator set.

## Section III. WHEEL MOUNTING KIT

### 17-20. General.

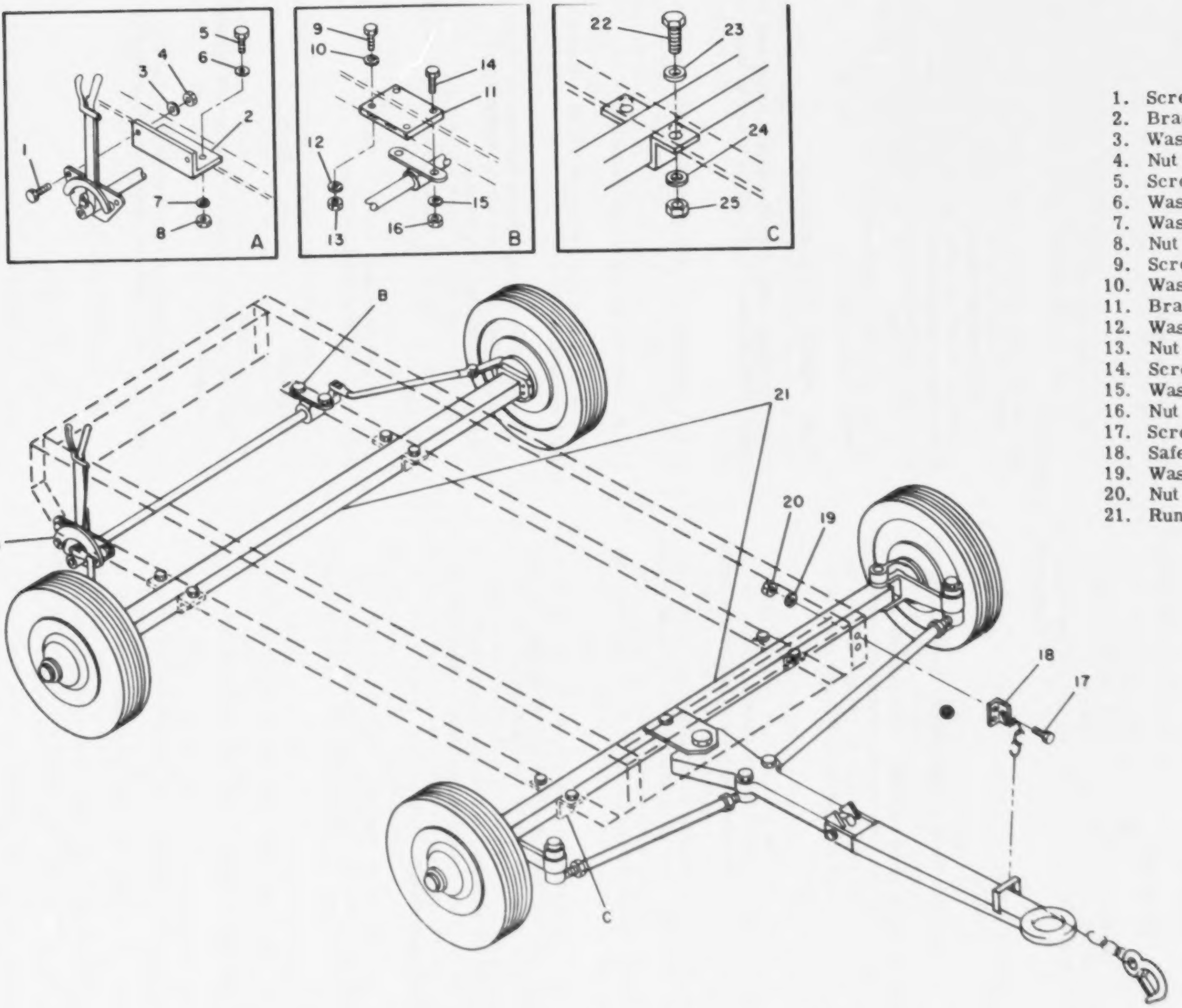
This wheel mounting kit, when installed, provides mobility for the engine generator set. The kit consists of front and rear running gear, a manual control brake lever, mounted on the skid base, and a towing bar with safety chains.

### 17-21. Removal.

a. Using a lifting device, with 10,000 pound capacity, hoist the engine generator set until the running gear wheels clear the ground.

Table 17-5. Electric Winterization Heater Control Box Testing

| Step | Test condition | Required result | Probable cause for improper result | Check out procedure |
|---|---|---|---|---|
| 1. | Position heater control box switch to ON and apply 230 Vac. Open switch S2; see figure 17-5. | Heater control box indicators DS301 should illuminate. | Defective fuse F301. | Check continuity of fuse. There should be continuity. |
| | | | Defective switch 301. | Check continuity of switch when positioned to ON. There should be continuity. |
| | | | Defective circuit breaker CB301. | With ohmmeter, check circuit breaker for correct operation. |
| | | | Defective indicator 301. | Check indicator for continuity. There should be some continuity. |
| | | | Defective diodes CR301, CR302, CR303 or CR304. | Check diodes with ohmmeter. |
| 2. | Close switch S2. | Voltmeters V2 and V3 should indicate 230 Vac and voltmeter V1 should indicate approximately 30 Vdc, and DS302 should illuminate. | Defective transformer T301. | See transformer test, paragraph 17-18. |
| | | | Defective relay K301. | Check relay per paragraph 17-18. |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ME 6115-545-34/17-6

1. Screw
2. Bracket
3. Washer
4. Nut
5. Screw
6. Washer
7. Washer
8. Nut
9. Screw
10. Washer
11. Bracket
12. Washer
13. Nut
14. Screw
15. Washer
16. Nut
17. Screw
18. Safety chain assy
19. Washer
20. Nut
21. Running gear assembly

17-6. Wheel Mounting Kit

b. Remove the wheel mounting kit and associated hardware in reverse order as illustrated in figure 17-6.

17-22. Inspection and Repair.

Refer to Operator and Organizational Maintenance Manual for wheel-mounting kit inspection and repair instructions.

17-23. Installation.

a. Using a lifting device, with 10,000 pound capacity, hoist engine generator set until bottom of skid base clears ground by approximately two feet.

b. Position front and rear running gear and lower engine generator set until it just rests on running gear axles.

c. Install kit with attaching hardware as illustrated in figure 17-6.

## Section IV. LOAD BANK

17-24. General.

a. The load bank is a balanced, three phase, four-wire device that can be used to apply a resistive load to the generator. The purpose of the resistive load is to provide a partial load for the set if the normal utility load is too low to keep the engine generator set operating without carbonization of the engine.

b. When the load bank is used in conjunction with the engine-generator set, the generator is protected against overloads by the load reject relay A41, incurred as a result of increases in utility load. The selected kw load of the bank is continually present. The load reject relay, utilized when the load bank mode selector switch is in the auto position, receives the output of the load measuring unit.

c. The load measuring unit senses the generator output (utility load plus load bank), should the combined load exceed 50% of the rated generator capacity 60 kw (i.e. 30 kw). The LMU output voltage applied to the load reject relay causes contacts within the load reject relay to close, resulting in the energizing of the trip coil of the Over Temperature Reset switch.

d. This action removes the selected load from the generator output allowing continued supply of the utility load without the risk of generator overload.

e. When the generators utility load diminishes the load bank may be reapplied by manually resetting the Over Temperature Reset switch.

f. Positioning the load bank select switch to the manual mode disables the trip feature previously described. Protection of the generator against overloads produced by combined load bank and utility loads is then the responsibility of the operator. The total load is displayed on the panel mounted kw meter. Should the displayed reading exceed the sets rated capacity, the operator must reduce or remove the load bank setting with the load bank selector switch.

g. The load bank incorporates a thermostatic switch which will operate the trip end of the Over Temperature Reset switch to remove the selected load from the generator when the ambient temperature reaches $450 \pm 15^{\circ}$ F. The thermostatic switch is fully operable in both manual and automatic modes of operation.

17-25. Removal and Disassembly.

a. Removal. Refer to Operator and Organizational Maintenance Manual and remove the load bank.

b. Disassembly. See figure 17-7 and disassemble the load bank.

17-26. Repair, Overhaul and Rebuild.

a. Test diodes per paragraph 14-10. Replace a defective diode.

b. Repair or rebuild wiring harness as required. Refer to Chapter 5, and to wiring schematic in Chapter 1 for wiring instructions.

c. Refer to figure 17-8 and perform load reject relay test.

d. **Rotary Switches.** Refer to Operator and Organizational Maintenance Manual.

e. **Fan and Motor Assembly.** Refer to Operator and Organizational Maintenance Manual.

(1) Removal. Refer to Operator and Organizational Maintenance Manual to remove the fan and motor assembly.

(2) Disassembly. See figure 17-9 and disassemble in the numerical sequence illustrated.

(3) Cleaning and inspection.

(a) Cleaning.

1. Blow out all dirt from inside field frame and wipe interior with a clean cloth.

CAUTION

Do not submerge armature, or field coils in solvent.

2. Clean field coils and frame thoroughly with a cloth dampened with cleaning solvent Federal Specification P-D-680. Dry thoroughly with compressed air.

3. Remove loose particles from armature with compressed air and wipe with a clean cloth dampened with cleaning solvent. Clean commutator lightly with number 00 sandpaper and remove all traces of dust with low-pressure compressed air.

4. Clean brush holders with a brush and cleaning solvent, Federal Specification P-D-680, and dry them thoroughly with compressed air.

5. Clean brushes with a clean, dry cloth only. Do not permit cleaning solvent to come in contact with the brushes.

(b) Inspection.

1. Test field coils for insulation breakdown with megger connected between frame and one coil terminal. Minimum resistance reading permissible is one megohm. Replace motor assembly if coil is defective.

2. Test armature for grounds with a test light. Touch a test light probe to the armature core and the other probe to a commutator bar riser. If test light glows, armature is grounded. Repeat test for all commutator bars.

3. Test armature for short circuits using a growler fixture.

(4) Repair.

(a) Housing and commutator end head.

1. Smooth minor scratches burrs, and dents on machined surfaces using a fine mill file.

2. Repair damaged threads.

(b) Armature.

1. Resurface commutator by removing no more than 0.005 inch during any one cut and no more than 0.002 inch on final cut. Check that the final diameter of commutator is not less than 0.925 inches.

2. If commutator diameter is satisfactory, undercut mica to a depth of 0.025 to 0.032 inch below commutator surface.

NOTE

Use care in undercutting. Do not widen commutator slots by removing metal from segments, and do not leave thin edge of mica next to segment.

3. After the mica has been undercut, remove all copper and mica particles with compressed air. Polish the commutator in a lathe with number 2/0 sandpaper while the armature is rotating at 1500 rpm. After polishing the armature, check that commutator diameter is not less than 0.925 inches. Replace if diameter is less.

4. After repair work has been completed, repeat steps 2 and 3 of e(3)(a) above.

(c) Field coil assembly.

1. Smooth minor scratches, burrs, and nicks on machined surfaces of frame using fine mill file.

2. Repair damaged threads in frame.

3. Replace motor assembly if field coil insulation resistance is less than one megohm.

(5) Reassembly. Reassemble fan and motor assembly in reverse order of disassembly.

(6) Bench tests.

(a) Energize the fan motor with 115 Vdc.

(b) Check the speed of the armature on the tachometer. Minimum speed should be 3600 rpm.

(c) Check the current draw on the ammeter. Maximum current draw should be 1.8 amperes.

(7) Installation. Refer to Operator and Organizational Maintenance Manual and install the fan and motor assembly.

f. **Circuit Breaker.** Refer to Operator and Organizational Maintenance Manual.

g. **Indicator Light.** Refer to Operator and Organizational Maintenance Manual.

h. **Load Reject Switch.** Refer to Operator and Organizational Maintenance Manual.

i. **Terminal Board.** Refer to Operator and Organizational Maintenance Manual.

j. **Thermostat.** Refer to Operator and Organizational Maintenance Manual.

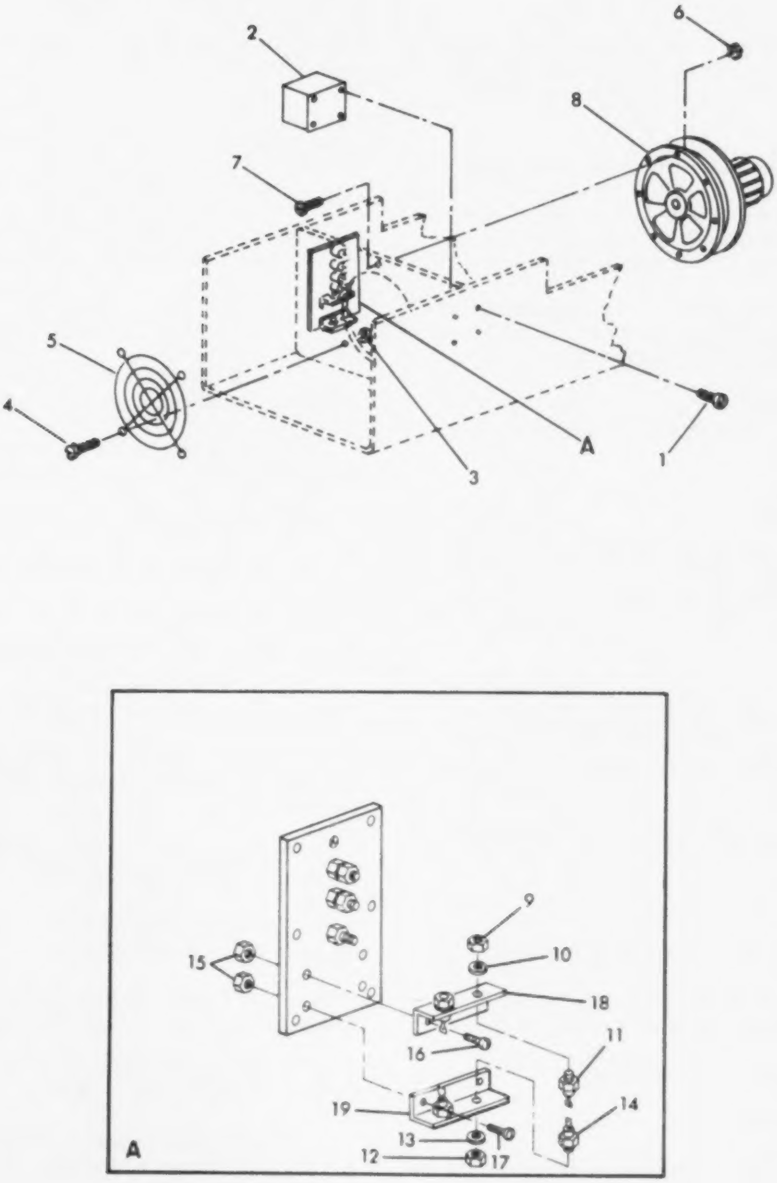
k. **Heater Elements.** Refer to Operator and Organizational Maintenance Manual.

l. **Replace all Defective Components.**

17-27. Reassembly and Installation.

a. Reassembly. See figure 17-7 and the Operator and Organizational Maintenance Manual and reassemble the load bank.

b. Installation. Refer to the Operator and Organizational Maintenance Manual and install the load bank on the generator set.



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1. Screw
2. Relay
3. Nut
4. Screw
5. Fan guard
6. Nut
7. Screw
8. Fan motor
9. Nut
10. Washer
11. Diode
12. Nut
13. Washer
14. Diode
15. Nut
16. Screw
17. Screw
18. Heatsink
19. Heatsink

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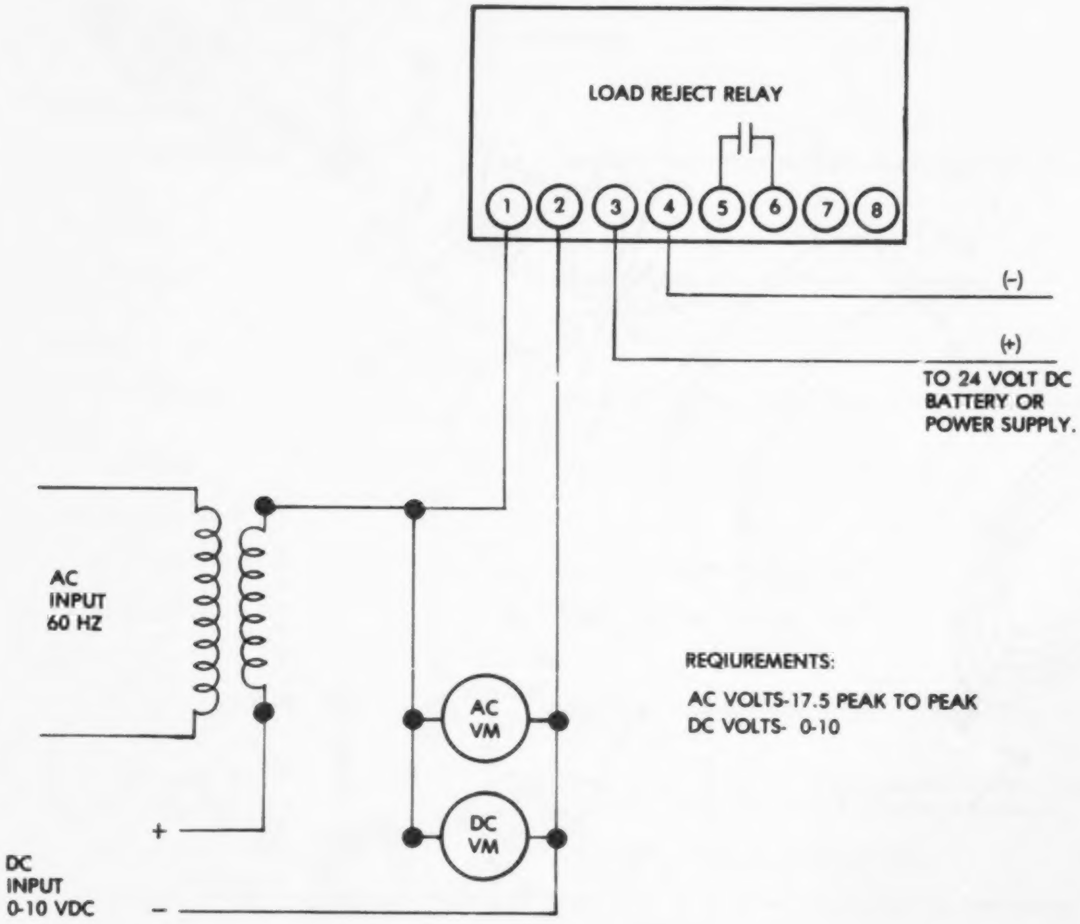
Figure 17-7. Load Bank


LOAD REJECT RELAY
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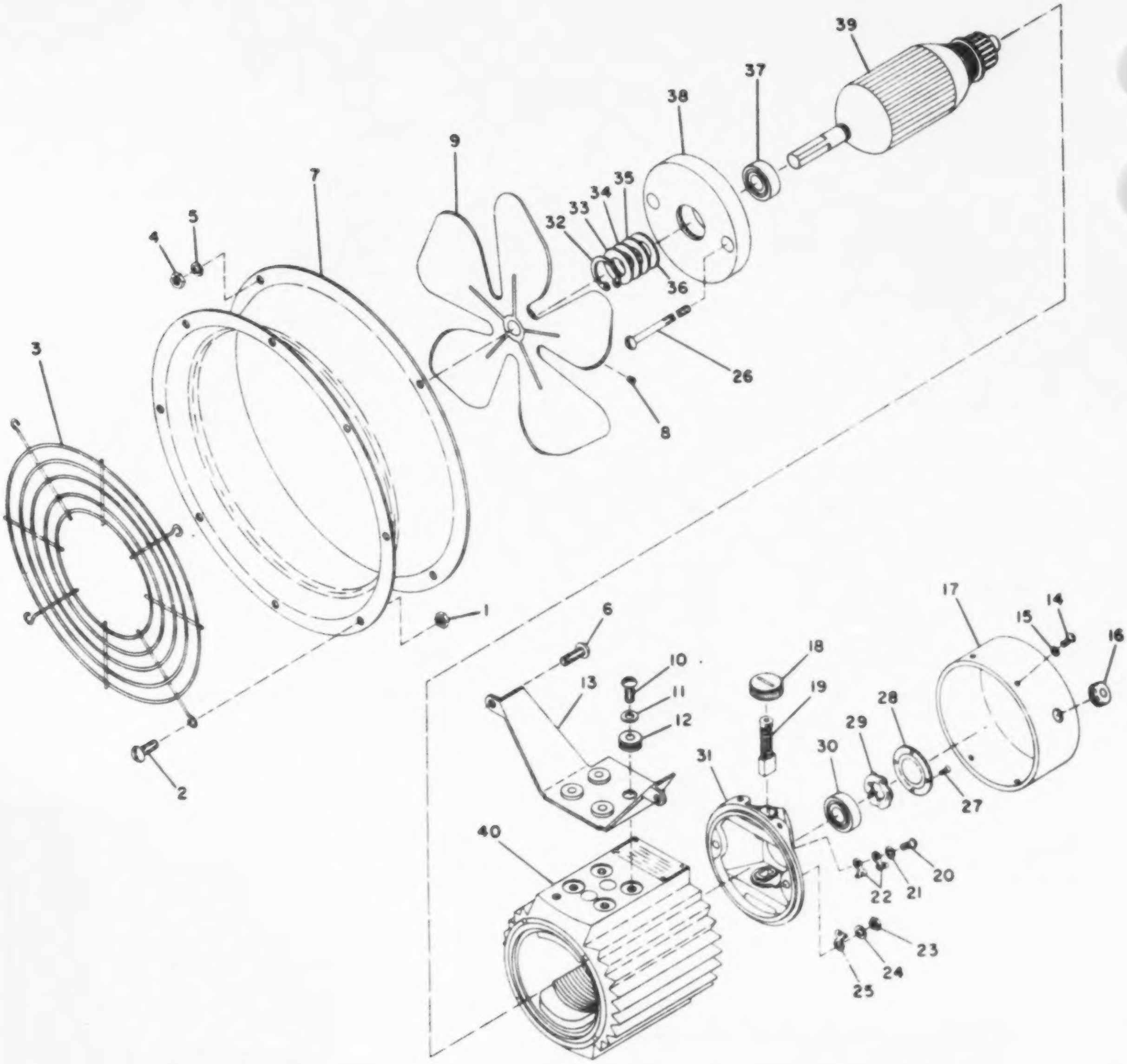
7
8
(-)
(+)
TO 24 VOLT DC
BATTERY OR
POWER SUPPLY.
AC
INPUT
60 HZ
AC
VM
DC
VM
+
DC
INPUT
0-10 VDC
–

REQUIREMENTS:

AC VOLTS-17.5 PEAK TO PEAK
DC VOLTS- 0-10

1. CONNECT AC AND DC POWER AS SHOWN.
2. RECOMMEND USE OF ISOLATION TRANSFORMER INCONJUNCTION WITH AN AUTO TRANSFORMER FOR AC VOLTAGE.
3. INCREASE DC VOLTAGE FROM 0 TO 10 VDC, CONTACTS AT TERMINAL #5 AND #6 WILL CLOSE NORMALLY AT 5 VDC.

Figure 17-8. Load Reject Relay Test Circuit.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1. Nut
2. Screw
3. Guard
4. Nut
5. Washer
6. Screw
7. Venturi
8. Setscrew
9. Fan
10. Screw
11. Washer
12. Grommet
13. Bracket
14. Screw
15. Washer
16. Grommet
17. Cover
18. Brush cap
19. Brush assy
20. Screw
21. Washer
22. Terminal lug
23. Nut
24. Washer
25. Terminal lug
26. Bolt
27. Screw
28. Cap
29. Washer
30. Bearing
31. End cap assy
32. Retaining ring
33. Shim
34. Shim
35. Shim
36. Shim
37. Bearing
38. End cap
39. Armature assy
40. Field assy

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Figure 17-9. Load Bank Fan and Motor Assembly

# APPENDIX A

## REFERENCES

A-1. Fire Protection.

| | |
|---|---|
| TB 5-4200-200-10 | Hand Portable Fire Extinguishers Approved for Army Users. |

A-2. Lubrication.

| | |
|---|---|
| C9100-IL | Identification List for Fuels, Lubricants, Oils and Waxes. |

A-3. Painting.

| | |
|---|---|
| T.O. 35-1-3 | Painting and Marking of USAF Aerospace Ground Equipment. |
| TM 9-213 | Painting Instructions for Field Use. |

A-4. Radio Suppression.

| | |
|---|---|
| MIL-STD-461 | Radio Interference Suppression. |
| TM 11-483 | Radio Interference Suppression. |

A-5. Maintenance.

| | |
|---|---|
| T.O. 00-25-225 | Repair of External Power Cables, Aeorspace Ground Equipment. |
| T.O. 00-25-234 | General Shop Practice Requirements for the Repair, Maintenance and Test of Electric Equipment. |
| T.O. 1-1-1 | Cleaning of Aerospace Equipment. |
| T.O. 1-1-2 | Corrosion Control and Treatment for Aerospace Equipment. |
| T.O. 1-1A-14 | Installation Practices for Aircraft Electric and Electronic Wiring. |
| T.O. 31-1-75 | General Maintenance Practices. |
| T.O. 35-1-11 | Organization, Intermediate and Depot Level Maintenance for FSC 6115 Non-Airborne Equipment. |
| T.O. 35-1-12 | Components and Procedures for Cleaning Aerospace Ground Equipment. |
| T.O. 35-1-26 | Repair/Replacement Criteria for FSC 6115 Aerospace Ground Equipment. |
| T.O. 35-1-524 | USAF Equipment Registration Number System Applicable to FSC 6115 Equipment. |
| TM9-1870-1 | Care and Maintenance of Pneumatic Tires. |
| MIL HDBK-705A | Military Standardization Handbook Generator Sets, Electrical, Measurements and Instrumentations. |

| | |
|---|---|
| TB 750-651 | Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems. |
| TM 38-750 | The Army Maintenance Management Systems. |
| TM 5-6115-545-12<br>TO-35C2-3-444-1<br>NAVFAC P-8-626-12<br>TM-000386-12 | Operator and Organizational Maintenance Manual. |
| TM5-6115-545-24P<br>TO-35C2-3-444-4<br>NAVFAC P-8-626-24P<br>SL-4-00038G | Organizational, DS, GS and Depot Maintenance Repair Parts and Special Tools List. |
| TM 9-6140-200-15 | Operation and Organizational, Field, and Depot Maintenance: Storage Batteries, Lead Acid Type. |
| TM 5-764 | Electric Motor and Generator Repair. |
| TM 5-6115-588-14<br>T.O. 35CA-1-111<br>NAFAC P-8-601<br>TM-6115-15/4 | Operator, Organizational, Intermediate (Field)(Direct and General Support) and Depot Maintenance Manual Including Repair Parts and Special Tools List for Auxiliary Equipment 15 Through 200 KW, DOD Family Generator Sets. |

A-6. Shipment and Storage.

| | |
|---|---|
| T.O. 35-1-4 | Processing and Inspection of Aerosapce Ground Equipment for Storage and Shipment. |
| T.O. 38-1-5 | Processing and Inspection of Non-Mounted, Non-Aircraft Gasoline and Diesel Engines for Storage and Shipment. |
| TB 740-97-2 | Preservation of USAMEC Mechanical Equipment for Shipment and Storage. |
| TM 740-90-1 | Administrative Storage of Equipment. |

A-7. Destruction of Material.

| | |
|---|---|
| TM 750-244-3 | Procedures for Destruction of Equipment to Prevent Enemy Use. |

A-8. Radioactive Material.

| | |
|---|---|
| TB 750-248 | Instructions for Safe Handling, Maintenance, Storage, and Disposal of Radioactive Commodities Managed by U. S. Army Mobility Equipment Command. |

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